Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Space and Matter.

REFERRING to NATURE of June 14 and to the interesting résumé on page 897 of Prof. Einstein's Nottingham lecture, I note that he virtually agrees with me in claiming matter as passive and space as active. Matter is that which is acted upon; space is that which acts. Matter is inert; space is energetic. Matter does nothing, though it serves to display the energy of which space is full: it merely sails placidly along the path of least resistance, like a straw in a stream or a leaf in the wind.

It used to be thought that potential or static energy existed in the ether, while locomotive energy was possessed by matter; but we now know that momentum is electromagnetic, and accordingly exists in the space around the unit of matter which displays it. So, strictly speaking, all energy belongs to space: matter only affords a means of detecting and using it.

There is no objection to an inert thing being able to receive and transmit energy; and yet when we say that matter is a form of energy, equal to mc^2 , it is clear from the occurrence of c that space must really be responsible for the energy. So also for the increase of energy due to motion, which is responsible for the kind of relative kinetic energy familiar to engineers; c is involved in that too. For $\frac{1}{2}mv^2 = c^2 dm$. As for the irregular or statistical energy that we call heat and usually consider material, the heat motion of particles is partly visible in the Brownian movement, which as temperature rises must grow in intensity. Whatever is true about the locomotion of particles is true also of this irregular motion.

We know that the mass of an electron is accounted for by the energy of its electrostatic field. So matter, strictly speaking, has no active properties at all. When we say that matter is a form of energy, we mean that its existence is the sign or symbol of certain kinds of energy in space, and affords a possible means of getting at it. (It would be pedantic and inconvenient to be perpetually remembering this, so we may still attribute momentum and kinetic energy and heat energy to matter.)

This applies to all matter. There is no discrimination between the so-called animated variety and any other. Hence the task of the biologist or the behaviourist to explain vital activity in terms of matter must be futile. Every part of every body must be controlled, guided, activated, by something in space. When an organism interferes with, or in, the course of Nature, it does so because it is actuated by something outside itself; something familiar in its effects, and usually called Life, but not yet discovered or formulated in proper terms.

Although matter has no energy and never does anything, yet it is to us the conspicuous thing, because our nerves, which are themselves material, respond to the perturbations of space; thereby stimulating our sense-organs, and giving us information about those perturbations. Matter is one of the perturbations, but it is entirely inert. Space is the primary and active thing.

Space with physical properties is usually called ether; but what those properties in themselves are, is the problem before us—a problem which must have deep-seated philosophical consequences.

OLIVER LODGE.

Normanton House, Lake, Salisbury, June 20.

No. 3166, VOL. 126]

Absorption of Sound at Oblique Incidence.

In the U.S. Bureau of Standards' *Journal of Research* for February 1930, pp. 289-296, there appears a description of apparatus employed by P. R. Heyl, V. L. Chrisler, and W. F. Snyder, for the investigation of the absorption of sound at oblique incidence. A plate of the material to be tested was placed at a flat elbow joining two cylindrical pipes in the way shown diagrammatically in the accompanying sketch (Fig. 1). The results obtained were compared with certain calculations made by me relating to the reflection of plane waves of sound from a flat surface.

The theory underlying the method appears to be that plane waves travelling down the pipe *A* will be reflected from the plate of material under test and will pass into *B* in accordance with the laws of rectilinear propagation as commonly employed in optics when the dimensions of the reflecting surface are large compared with the wave-length. In the experiments at the Bureau of Standards, however, the diameter of the pipes which convey the sound to and from the test plate was only a fraction of the wave-

FIG. 1.

length of the sound employed, and an assumption of rectilinear propagation at the elbow seems scarcely to be justified. Part of the energy of a plane wave travelling along *A* will pass into *B* by diffraction, and also any sound reflected from the test plate will spread partly into *A* and partly into *B*. For these reasons I am inclined to think that very little value can be attached to the coefficients of absorption at oblique incidence which are given in the paper referred to. At any rate, they are certainly not the coefficients for plane waves at oblique incidence.

One of the substances tested at the Bureau of Standards was 'akoustolith', an acoustic tile similar to certain acoustic plasters concerning which I have made theoretical deductions leading to the conclusion that the coefficient of absorption for plane waves at oblique incidence would, except near grazing incidence, be greater than at normal incidence (*Proc. Roy. Soc., A*, 115, pp. 417-419; 1927). Heyl, Chrisler, and Snyder found with their apparatus that the absorption of akoustolith (at 512 and 1024 cycle/sec.) was less at 45° and 60° than at normal incidence, and less at 45° than at 60°. To explain the discrepancy between their observations and the theoretical conclusions, they invoke the aid of "a thin layer of air close to the absorbing surface" where the "differential equation for sound motion in air is not valid" (*loc. cit.*, p. 290). In this layer they imagine there is a rotational motion of the air particles, and conclude that "it is unsafe to apply to such a region mathematical analysis involving the assumption of the existence of a velocity potential. Theoretical conclusions based on such reasoning are invalid" (p. 295). There appears to be no evidence that this layer exists (or that, even if it exists, it exerts any perceptible effect on sound absorption) apart from the discrepancy referred to