QUERIES RESPECTING ÆTHER

THE following speculations first appeared in the pages of the *Engineer* :—

When light and caloric were supposed to have a material existence, the hypothesis of the universal existence of a highly elastic medium was unnecessary, since matter might with the utmost freedom be projected through vacuous space ; but as light and heat are now generally admitted to consist not of transmitted matter, but of transmitted vibratory motion (and why may not electricity, so freely interchangeable with the former, be admitted into the same category ?), the necessity of the existence of a transmitting medium, pervading infinite space, becomes at once apparent ; and this medium, hitherto not cognisable to our senses, has been termed æther.

But it has been further assumed that æther is alone capable of transmitting the extremely rapid vibration of light and heat, and that it must therefore necessarily pervade or permeate all kinds of sensible matter. The questions proposed to be raised in this communication are the necessity of this interstitial hypothesis, and the probable capability of ordinary matter to transmit the vibrations of light and heat.

It is now generally admitted that when a body becomes heated, its own particles, and not those of the supposed interstitial æther, are thrown into a state of vibratory motion, the amount of heat corresponding probably to the amplitude of the vibrations ; hence a certain amount of energy has been communicated to those particles, and, at all events, in the case of celestial mediations, the molecules of æther must previously have possessed the energy or *vis viva* which they have communicated. Hence æther, being susceptible of *vis viva*, has recently been admitted to be ponderable, but this admission is not a necessary consequence, for although the idea of the existing energy is associated with that of weight, in consequence of the constant energy acquired by gravitation having been taken as the measure or unit of energy, however acquired, there is no necessary connection between them. Suppose, for example, a flea were placed on an orbilating planet of the size of a pumpkin, while its muscular energy would remain undiminished, its weight would be infinitesimal, and the first leap would obviously plunge it into infinite space, to perform subsequently, perhaps, an independent orbit.

Further, it has been shown from the investigations of Mr. Norman Lockyer, to whom the progress of solar physics is so largely indebted, that incandescent gases are capable of initiating vibrations of definite periods, which are, moreover, occasionally accelerated or retarded by the proper motion of the emitting gas. What reason can there then be for doubting that gaseous matter is capable of transmitting heat waves, and if so, of likewise transmitting the waves of light, since the two are so intimately connected by the identical phenomena of reflection, refraction, and polarisation? May not in fact, in some instances, the perceptions of light and heat be but different sensuous impressions produced by the same vibrations ?

The only basis on which the interstitial-æther hypothesis rests is the assumed incapacity of ordinary matter, whether in the solid, liquid, or gaseous state, to transmit the vibrations of light and heat, because the only vibrations, namely, sonorous, with which we are acquainted, are almost immeasurably slower than those of light and heat, the one being numbered by at most a few thousands, the other by hundreds of millions of millions in one second of time.

But it must be borne in mind that sonorous vibrations are always longitudinal, in the production of which repulsive forces are alone concerned ; whilst, on the contrary, light and heat vibrations are necessarily transverse, and the production of these is solely due to attractive forces. Now these respective forces obey very different laws, for whilst attractive forces obey generally, and probably universally, the laws of the inverse square of the distance, molecular repulsion must obviously, at all events in gaseous matter, obey the laws of the inverse cube of the distance ; therefore, from the rate of transmission of longitudinal vibrations, nothing can be predicted respecting the rate of transmission of transverse waves. It has been asserted that molecular repulsion is a dynamical resultant effect, and, therefore, incapable of expression by a statical law ; but it is very doubtful whether molecular attraction is not equally a dynamical sequence, and, therefore, not a whit more entitled to claim a statical law than the former. Now, in the denser forms of matter, namely, the solid and liquid, it appears that the wave-lengths of created transverse vibrations are indefinitely modified, probably by the more energetic action of repulsive forces ; for whilst any given kind of matter in the solid or fluid state is found, when incandescent, to emit light and heat waves of all lengths, and so to form a continuous spectrum, the same matter in the form of incandescent gas will emit only a few sets of waves of definite and invariable lengths ; and, moreover, some of these wave-lengths are frequently found to bear very simple numerical ratios to each other. And even in gaseous matter it has been observed that the bright lines in the spectrum become narrower and more sharply defined by rarefaction ; and, on the contrary, broader and less defined by condensation. Moreover, as regards density, the absorption bands in the spectrum appear to obey the same law as the bright lines. In other words, every kind of matter appears to be capable of emitting or absorbing its own peculiar waves, according to its tenacity ; that is, as the results of molecular attraction are less and less interfered with by those of repulsion. The well-known peculiar incapacity of any given translucent substance to transmit the heat-rays emitted by a heated portion of the same substance ; or, in other words, the ability of the molecules to freely appropriate the wave motion that has been induced by some intervening medium by similar molecules, seems further to argue that ordinary matter is capable of assuming vibrations having the extreme rapidity of those of light and heat. And that there exists no valid ground for a distinction between light and heat in this respect is further confirmed by the experiments of Prof. B. Stewart, who has shown that the emission of light by incandescent bodies closely corresponds with their absorptive power (whether selective or otherwise) when not incandescent ; and, further, that even in the decomposition of light into true polarised beams by the tourmaline it emits, when incandescent, the ray that is otherwise absorbed.

Can there, then, be any valid reason for doubting the ability of ordinary matter to transmit those transverse vibrations, which it is obviously capable of either absorbing or emitting : and if so, what ground is there for the hypothesis that the transmission of light and heat waves necessitates the presence of imperceptible æther in the interstices of perceptible matter ?

If the existence of æther in infinite space, essential to the undulatory theory, be admitted, it may be asked, how is it possible to conceive its exclusion from any portion of space ? A very simple hypothesis propounded by the writer in the introduction to the last edition of his "Elements of Physics" will meet this difficulty, namely, that æther (like its fluid namesake with water) is *immiscible* with known gaseous matter. This, it must be admitted, is sheer hypothesis ; but if true, it must ever remain so, as being beyond the reach of human ken. But of this we may rest assured, that if it be not wanted in and around even our corporeal frames, it is not there ; the contrary supposition would be inconsistent with the infinite wisdom of the Creator of the universe.

CHARLES BROOKE