

### Letters to the Editor.

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#### Quantum Radiation.

THE fraction  $\pi/(e^\pi - 1)$ , by which the quantum theory of radiation differs from the classical theory, is so important that it seemed of interest to study it for its own sake. I accordingly wrote to my brother Alfred Lodge, as a pure mathematician, asking him what he had to say about it. He directed my attention to some points which may be of interest to other students of Planck's theory as expounded in Great Britain by Dr. Jeans. First, that the function was studied by John Bernoulli and expanded in a series involving his particular numbers; and next, that it is the ratio of simple interest to continuous compound interest for the same period. Or in other words, the compound interest  $h\nu$  on  $E$ , the actual basic energy, is equal to the simple interest on  $RT$ ; so that  $E$  has to be reduced below the average value in order to allow compound interest to be taken on it, while the rate of interest,  $\pi$ , is apparently dependent on the ratio  $\nu/T$ .

The expansion spoken of above runs thus :

$$\frac{\pi}{e^\pi - 1} = 1 - \frac{1}{2}\pi + \frac{1}{6}\frac{\pi^2}{2!} - \frac{1}{30}\frac{\pi^4}{4!} + \frac{1}{42}\frac{\pi^6}{6!} - \frac{1}{30}\frac{\pi^8}{8!} + \dots$$

the coefficients being the successive Bernoulli numbers. A peculiarity of this series is that there are no odd powers of  $\pi$  after the first; looking as if everything outside classical mechanics depended on square numbers, like the radii of Bohr orbits.

Apart from the expansion so well known to pure mathematicians, the physical suggestion is that while  $RT$  is the average energy per degree of freedom per atom, the actual individual atomic energy  $E$  accumulates continuously at compound interest, the rate of which is  $\pi = h\nu/RT$ , until some atom has attained the extra accumulation  $h\nu$ , which it then emits. So that  $E(e^\pi - 1) = RT\pi = h\nu$ .

Interest is compound until it is paid, and then begins again. Thus  $E$  is first left to grow until it equals  $Ee^\pi$ ; then  $E(e^\pi - 1)$  is given out, and  $E$  is left to grow again until it again equals  $Ee^\pi$ , when another dividend is paid.

The accumulating unit is the atom, the energy of which is  $RT$  or  $3RT$  only on the average. The actual energy rises by the compound interest of thermal agitation, until an emission occurs from those which on the ground of probability have reached the critical stage: small emissions at low frequency, large emissions—if they can occur—at high frequency.

The energy  $E$  is presumably internal electronic energy, the only kind of disturbance which can affect the ether and either radiate or absorb. It is doubtless associated with some particular frequency of revolution or internal vibration. Mere molecular or mechanical energy alone would not radiate (matter alone has no link with the ether); if it did we should have the equi-partition law and its troubles. Even the internal mechanism does not radiate save in jumps or jerks. Within the atom the energy grows continuously, but it is given out spasmodically.

All this is suggestive, and may probably be put in an educational manner. I need scarcely emphasise the singular beauty of the modern theory of black-

body radiation, and the fundamental way in which we are beginning to get down to the mode of interaction between matter and ether.

OLIVER LODGE.

May 9.

#### D. C. Miller's Recent Experiments, and the Relativity Theory.

EVIDENCE against the validity of the relativity theory was unfolded before the annual meeting, April 28, of the National Academy of Sciences by Prof. Dayton C. Miller, of the Case School of Applied Science, who, by a much-refined and improved repetition of the so-called Michelson-Morley experiment, has shown that there is a definite and measurable motion of the earth through the ether.

Prof. Miller has obtained on four occasions a small positive effect at Cleveland, namely, the equivalent of a velocity of about 2 kilometres per second at the altitude of the Case School of Applied Science, and about 3 kilometres per second on the level of the neighbouring hills. Whereas at the altitude of the Mount Wilson Observatory, in four consecutive experiments spread out over four years, he obtained with increasing precision a positive result of 10 kilometres per second, his last result this April justifies him in asserting that the result is correct to within one-half kilometre per second.

The technical details of these experiments themselves will be described shortly in special papers by Prof. Miller himself. The purpose of the present letter is to say a few words about the implications of these results from the point of view of the relativity and the ether theories.

In the first place, then, this definite result is entirely antagonistic to the Einstein relativity theory, which in fact could not be adapted to the results of Prof. Miller by any conceivable modifications, unless the very fundamental principles of Einstein's theory were given up. This, however, is as much as to say that Miller's results knock out the relativity theory radically.

In the second place, from the point of view of an ether theory, this set of results, as well as all others previously discovered, are easily explicable by means of the Stokes' ether concept, as modified by Planck and Lorentz, and discussed by the writer in a *Phil. Mag.* paper (1919).

Without entering into the mathematical details associated with this statement, we may say only that Prof. Miller's results, as obtained in Cleveland and Mount Wilson, are given immediately by the main property of such an ether, namely, to adhere almost completely to the surface of the earth, and therefore to share almost entirely its translational motion over its surface, and to have a gradually increasing velocity relative to it when we go higher and higher up.

In the third place, the result of the recent *rotational* terrestrial experiment at Clearing, Ill., near Chicago, which gave a full effect associated with the spinning motion of the earth, can be accounted for by making the natural assumption that our globe, being almost perfectly spherical and having a purely gravitational grip upon the ether, does not appreciably drag it in its rotatory motion. Also the deflexion of the light rays around the sun to the amount claimed by the Einstein formula can be easily accounted for by means of a compressible ether provided its dielectric constant is related to its density and pressure by a very simple formula published by me a few years ago in the *Philosophical Magazine*.

The amount of additional evidence for the reality of Prof. Miller's beautiful results afforded by his tables