THE LUMINIFEROUS ÆTHER

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BY

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THE LUMINIFEROUS ÆTHER.

Two properties of the luminiferous æther appear to be known and measurable with a high degree of accuracy. One is its ability to transmit light at the rate of 186,300 miles per second,* and the other its ability to transmit from the sun to the earth a definite amount of heat energy.

In regard to the latter, Herschel found, from a series of experiments, that the direct heat of the sun, received on a body at the earth capable of absorbing and retaining it, is competent to melt an inch in thickness of ice every two hours and thirteen minutes. This is equivalent to nearly 71 foot-pounds of energy per second.

* Professor Michelson found the velocity of light to be 299,740 meters per second in air, and 299,825 meters in a vacuum, giving an index of refraction of 1,000,285 "Journal of Arts and Science," 1879, vol. xviii., p. 390.

In 1838 M. Pouillet found that the heat energy transmitted from the sun to the earth would, if none were absorbed by our atmosphere, raise 1.76 grammes of water 1° C. in one minute on each square centimeter of the earth normally exposed to the rays of the sun.*

This is equivalent to 83.5 foot-pounds of energy per second, and is the value used by Sir William Thomson in determining the probable density of the æther.† Later determinations of the value of the solar constant by MM. Soret, Crova, and Violle have made it as high as 2.2 to 2.5 calories. But the most recent, as well as the most reliable, determination is by Professor S. P. Langley, who brought to his service the most refined apparatus yet used for this purpose, and secured his data under favorable conditions; from which the value is found to be 2.8 ± calories ‡ with some uncertainty still remaining in regard to the first figure

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* *Comptes Rendus*, 1838, tom. vii. pp. 24–26.

† "Trans. Roy. Soc. of Edinburgh," vol. xxi. part 1.

‡ *Am. Journ. of Arts and Science*, March, 1883, p. 195. Also *Comptes Rendus*.

of the decimal. We will consider it as exactly 2.8 in this analysis, according to which, there being 7,000 grains in a pound and 15.432 grains in a gramme, we have for the equivalent energy

$$\frac{2.8\times 15.432}{7,000}\times\frac{9}{5}\times\frac{772\times 144}{0.155\times 60}=$$
133 foot-pounds

per second for each square foot of surface normally exposed to the sun's rays, which value we will use. Beyond these facts, no progress can be made without an assumption. Computations have been made of the density, and also of the elasticity, of the æther founded on the most arbitrary, and in some cases the most extravagant, hypotheses. Thus, Herschel estimated the stress (elasticity) to exceed

$17\times 10^9=(17,000,000,000)$ pounds per square inch;*

and this high authority has doubtless caused it to be widely accepted as ap-

* "Familiar Lectures," p. 282

proximately correct. But his analysis was founded upon the *assumption* that the density of the æther was the same as that of air at sea-level, which is not only arbitrary, but so contrary to what we should expect from its non-resisting qualities, as to leave his conclusion of no value. That author also erred in assuming that the tensions of gases were as the wave-velocities in each, instead of the mean square of the velocity of the molecules of a self-agitated gas; but this is unimportant, as it happens to be a matter of quality rather than of quantity. Herschel adds, "Considered according to any hypothesis, it is impossible to escape the conclusion that the æther is under great stress." We hope to show that this conclusion is not warranted; that a great stress necessitates a great density; but that both may be exceedingly small. A great density of the æther not only presents great physical difficulties, but, as we hope to show, is inconsistent with the uniform elasticity and density of the æther which it is believed to possess;

and every consideration would lead one to accept the lowest density consistent with those qualities which would enable it to perform functions producing known results.

In a work on the "Physics of Æther," by S. Tolver Preston, it is estimated that the probable inferior limit of the tension of the æther is 500 tons per square inch, a very small value compared with that of Herschel's. But the hypothesis upon which this author founded his analysis was—The tension of the æther exceeds the force necessary to separate the atoms of oxygen and hydrogen in a molecule of water; as if the atoms were forced together by the pressure of the æther, as two Magdeburg hemispheres are forced together by the external air when there is a vacuum between them. This assumption is also gratuitous, and is rejected for want of a rational foundation.

Young remarks: "The luminiferous æther pervading all space is not only highly elastic, but absolutely solid."* We are

* "Young's Works," vol. i. p. 415.

not certain in what sense this author considered it as solid; but if it be in the sense that the particles retain their relative positions, and do not perform excursions as they do in liquids, it is a mere hypothesis, which may or may not have a real existence. If it be in the sense that the particles suffer less resistance to a transverse than to a longitudinal movement, there are some grounds for the statement, as shown in circularly-polarized light. Bars of solids are more easily twisted than elongated, and, generally, the shearing resistance is less than for a direct stress. It certainly cannot be claimed that the compressibility of the æther (in case we could capture a quantity of it) is less than that of solids.

Sir William Thomson made a more plausible hypothesis, by assuming that "the maximum displacement of the molecules of the æther in the transmission of heat energy was $\frac{1}{50}$ of a wave length of light, the average of which may be taken as $\frac{1}{50000}$ of an inch." Hence the displacement was assumed to be $\frac{1}{2500000}$ of