past each other. In this way, the experiments on diffusion have given us the viscosity of air and other gases.

The mean free path, for example, follows quite accurately the law: $l = 3\varkappa/\varrho\bar{v}$ (20)

where $\varkappa$ is the viscosity of the gas, and $\bar{v}$ the mean velocity of the molecule in cms per second, and ϱ the absolute density.

It is important to notice that in the case of the aether, viscosity passes into rigidity, by a process of reasoning fully explained in *Daniell's* Principles of Physics, 3rd ed., 1895, p. 227. In calculating the mean free path of the aetheron, we use the rigidity of the aether at the solar surface, 1800, because both the density and rigidity of the aether vary with the distance from the sun, as already explained in section 2. Thus for the aetheron the mean free path is $l = 572959$ kms.

It is a fundamental doctrine in the kinetic theory of gases that all gases have an equal number of molecules in unit volume, under like conditions of temperature and pressure; but it is not yet possible to decide on the absolute value of this number, different estimates being indicated by various eminent authorities: $N = 19 \times 10^{18}$ (*Maxwell*), $N = 1000 \times 10^{18}$ (*Crookes*), $N = 6000 \times 10^{18}$ (*Kelvin*).

About all we can say is that the number of molecules in a cubic centimetre of gas at the ordinary temperature and pressure probably is not smaller than that assigned by *Maxwell*, $N = 19 \times 10^{18}$, the latest determination being 27×10^{18} (cf. *Crowther*, Molecular Physics, Phila., 1914, p. 3).

Using the value for the aether,

$$\bar{v}_2 = 471239000 \text{ m}$$

and for Hydrogen, $\bar{v}_1 = 1859$ m

we have by the principle first enunciated by *Maxwell* (Scient. Pap. 2.365), that »on the average every molecule great or small will have the same energy of motion«, the equation:

$$\tfrac{1}{2} m_1 \bar{v}_1{}^2 = \tfrac{1}{2} m_2 \bar{v}_2{}^2 \tag{21}$$

which gives

$$m_2 = m_1 (1859^{*)})^2/(471239000)^2 = 15.56232 \times 10^{-12}. \tag{22}$$

Thus it follows that an aetheron has a mass of 15.56 millionths of a millionth of the mass of a Hydrogen molecule. This is equivalent to 2.7389×10^{-8} of an electron, or about one thirty-six millionth of an electron.

If we take the density of the aetheron as equal to that of the Hydrogen molecule, we find by calculation that the radius of the aetheron is equivalent to

$$r = 1/4005.36 \cdot H \tag{23}$$

or one four-thousand-and-fifth of the radius of a Hydrogen molecule. This explains why the aether so readily penetrates all bodies, even the most solid. It makes the size of an aetheron to a molecule of Hydrogen as a globe two miles in diameter is to the earth. Between masses as large as our terrestrial globe or larger, globes two miles in diameter would freely penetrate in great numbers, even if the larger globes were in contact, which of course is not the case with any solid or liquid, and still less is this true of a gas, in which the molecules are separated by distances relatively immense in comparison with the diameters of the molecules.

If the molecule of Hydrogen be taken to have a radius of 1.34×10^{-8}, that of the aetheron becomes

$$r = 1.34 \times 10^{-8}/4000 = 3.346 \times 10^{-12}, \text{ nearly.} \tag{24}$$

To form a convenient picture of the small size of the aetheron compared to the Hydrogen molecule, we may recall the trifling height of a mountain a mile high compared to the immense radius of the earth. If other molecules be larger than Hydrogen, as is generally supposed to be true, then the aetheron will be a small globe of the size of a moderate mountain peak 10000 feet high; so that the various molecules will resemble Venus and the earth, Uranus and Neptune, Jupiter and Saturn.

To fix upon a more familiar everyday image of this world structure, we may imagine a box filled with large oranges, and the finest dust, like that of lime, or smoke from a cigar, penetrating the relatively vast spaces between the oranges, which however should not be in contact, but in rapid motion. If now the cigar smoke, or the particles of lime dust, be imagined to have stupendous velocity, flying hither and thither with inconceivable speed, and thus moving with the utmost freedom in the open spaces between the oranges, as well as outside of them, we shall have a very good image of the behavior of the aether in respect to matter.

The aether not only penetrates all matter freely, but even waves in it pass through all physical bodies, with only the hindrance incident to refraction and dispersion such as we see in light. The refraction is due to the unequal resistance offered by matter to the advance of the wave front, and the dispersion to unequal resistance to various wave lengths. Shorter waves encounter relatively more resistance, because their oscillations are more rapid, and thus the aether yields and adapts itself less easily to the resisting molecules in the path of the waves, when the waves are short, and the changes, due to their advance, extremely rapid.

7. The geometrical and physical significance of the potential.

In the Mémoires of the Paris Academy of Sciences for 1782, p. 113, *Laplace* introduces the use of the analytical expression since known as the potential, from the designation first used in 1828 by the English mathematician *George Green* (Essay on the application of mathematical analysis to the theories of electricity and magnetism, Nottingham, 1828). The potential is defined thus:

$$V = M/r =$$
$$= \iiint \{\sigma / \sqrt{[(x-x')^2 + (y-y')^2 + (z-z')^2]}\} \, dx \, dy \, dz \,. \tag{25}$$

This expression has come into the most extensive use in all the physical sciences, and been of the highest service in the mathematical theory of gravitational attraction, magnetism, electrodynamic action, and also in theory of static electricity.

But it is very remarkable that up to the present time an expression of such universal use has not been given a clear geometrical or physical interpretation. The difficulty doubtless arose originally from beliefs like that expressed by *Laplace*, in the opening paragraph of the Méc. cél. I, 1799, that the »nature of force is now and always will be unknown«.

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*) *Joule's* value of molecular velocity of Hydrogen, which makes the aetheron perhaps a little too large.