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NR. 57-SEE (=195-SEE)

TITLE: SEE, T.J.J.

Wave Theory of Gravitation

195-SEE SEE, T.J.: WAVE THEORY OF GRAVITATION --- Despite high recommendation by Tesla and by psychic E. Cayce and others, the "Wave-Theory of the Aether" has been quite completely ignored by most all scientists. The noted astronomer Capt. T.J.J. See explained gravitional, magnetic and electrostatic fields as longitudinal or compression waves in the Ether, of approximately the same magnitude as the distances over which they operate. Light, heat and radio are described as transverse or shear waves in the Ether...When the longitudinal Ether waves that radiate from masses are coupled, they produce a relative Ether vacuum between them, and the bodies are pushed together. The apparent mass of an accelerating body is caused by increasing drag resistance from the viscous Ether. If a body is rotated at a certain speed, an associated Ether vacuum is produced which prevents transmission of the gravitational force. This opens the way to anti-gravity levitation ...The theories of Ch. Brush, Dr. Nieper, Prof Nipher (v.i.) all find unification herein...Includes bibliography, review, and 2 articles by See introducing his ideas ...30 pp..

'Nov 37 Pop Sci

New Theory Suggests Universe Is Shrinking

IS THE WORLD becoming a smaller place to live in? To account for recent discoveries at Mt. Wilson Observatory in California, Dr. S. Sambursky, physicist at Hebrew University, Jerusalem, proposes the startling theory that the universe and everything in it is slowly shrinking, including even our fundamental standards of length and energy.

Just the opposite view was held a few years ago. When astronomers observed a puzzling reddish tinge in light from distant nebulæ, they interpreted the phenomenon as evidence that these celestial bodies were rushing away from us and outward into space as fast as 25,000 miles a second—in other words, that the universe was expanding at explosive speed. The result would be to increase the apparent wave length of light from the retreating nebulæ, shifting their color toward the red end of the spectrum or rainbow of hues by which scientific observers classify light rays.

More recently, it has been discovered that the "red shift" actually observed through the big Mt. Wilson telescope does not quite correspond with the amount called for by such a theory. Astronomers have been casting about for a new one, which Dr. Sambursky now supplies. A "red shift" could also be produced, he points out, if everything between us and the nebulæ was gradually getting smaller. Substituting mathematical factors based upon his shrinking-universe hypothesis in the same calculations used to test the expanding-universe idea, he obtains figures that appear to check with the observed facts.

As startling to physicists as the Einstein theories of relativity, the new conception implies that their basic units are constantly diminishing in size instead of remaining constant. One of the shrinking quantities is the length of the radius of an electron, smallest particle of matter. Another is "H," a unit of energy upon which measurements of photo-electric cells, among other things, are based. The shrinking value of "H" also provides Dr. Sambursky with a new mathematical explanation for the familiar but little-understood phenomenon of gravity.

While the changes in the "measuring rods" of physics are too small to have a direct bearing on anyone's daily life, Dr. Sambursky maintains that they are nevertheless appreciable enough to be detected in the course of time. To prove or disprove his theory, he proposes measuring the present value of the wave length of a ray of light and repeating the test 350 years from now. Red light from a chemical element called cadmium, which can be measured in the laboratory with great accuracy, would be suitable. At the end of three and a half centuries, if the new theory is correct, the wave length of the red cadmium light should be found to have decreased in length by approximately one twenty-five-thousandth of an inch.

Will Einstein Theory Fall?

Pop Sci Oct '27

THE Einstein theory of relativity soon may fall, and we may have to look for another explanation regarding the mysterious movements of the universe. Professor Einstein himself has just admitted it. If results obtained recently by Prof. Dayton C. Miller at Mount Wilson Observatory are confirmed, he says, it means that the relativity theory does not hold.

For Professor Miller's results indicate the earth's motion through the ether. According to the relativity theory, it should never be possible for any one on earth to detect this motion. If all things in the whole universe—planets, stars, and ether—are moving at the same rate and in the same direction, the results of experiments on earth would be exactly the same as if all were standing still.

But if the earth and other bodies were moving through stationary ether, or at different rates, then there should be a drifting of the ether in their paths that could be observed from earth.

Professor Miller first made his experiments from an underground chamber, just as Professor Michelson and Professor Gale of the University of Chicago have been doing in tests of the Einstein theory. Like them, he could detect no motion — evidence substantiating the Einstein theory.

Their results, however, possibly might be explained by "ether drag." That is, in some way heavy bodies, such as the earth, drag along a certain amount of ether in their motion, leaving the more distant ether unaffected.

To test this, Professor Miller repeated his experiment at Mount Wilson, which is about a mile high. And here he obtained the surprising results that may contradict the relativity theory. He found a marked effect that seemed to vary with altitude.

Tiniest Particle May Be Etheron

ARE the electron and its consort, the proton, after all, the ultimate tiniest units of matter? If not, then what is the smallest thing in the universe?

Sir J. J. Thompson, noted British physicist, recently declared his belief that even these infinitesimal electrified particles are divisible into still simpler pieces to be revealed by further study. Present theory holds that every atom of matter is composed of one or more protons, around which revolve one or more electrons. The atom itself is so small that it takes seven figures in fractions to measure it. The electron is 1800 times as small as an atom, and the proton even tinier. Yet even these, Thompson declares, are insufficient to explain all of the atom's behavior.

An answer may be found in the remarkable theory just advanced by Capt. T. J. J. See, U. S. N., mathematician and astronomer. From studies of gravitation, he concludes that the smallest thing is an infinitesimal particle of ether called the etheron. So fine are these ether particles that they freely penetrate the earth. "If atoms of common gas such as hydrogen, nitrogen or oxygen be imagined the size of lemons, oranges or grapefruit," he explains, "then on this same scale the electron is like a coarse grain of sand, and the etheron is like a fine particle of smoke from a cigar." Pop Sci. DEC. '27

Rex Research

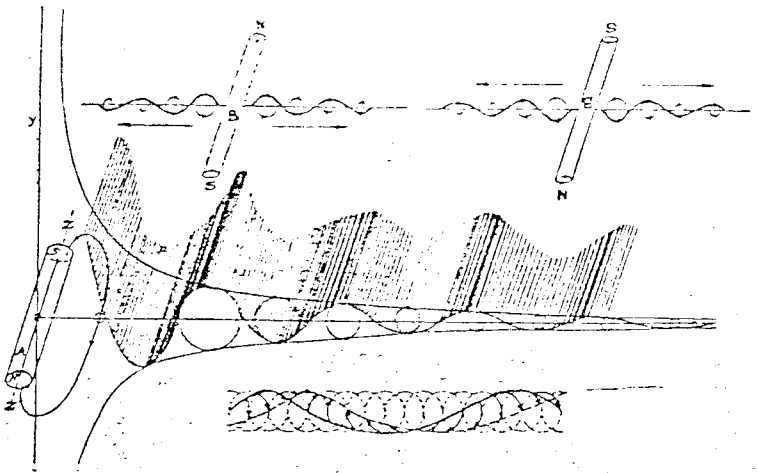
New Theory of Magnetism

By T. J. J. See, Ph. D.

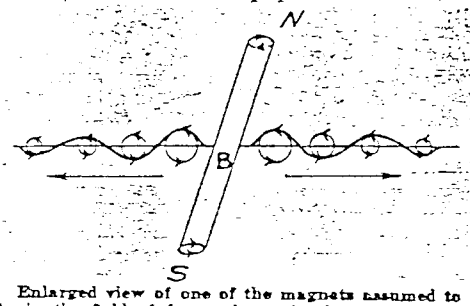
Professor of Mathematics, U. S. Navy.

IT is scarcely necessary to point out to the readers of PRACTICAL ELECTRICS that although we have had many notable treatises on magnetism since the first great work published in the year 1600 by Dr. Gilbert, of Colchester, physician to Queen Elizabeth, yet in all these modern treatises not a single explanation worthy of the name has been offered on the *cause* of magnetism! The result is a great need for a working theory of magnetism which will enable us to see what is going on in the field about a magnet.

The theory herein set forth was developed by the writer in 1916, and first published in a work entitled *Electrodynamic Wave-Theory of Physical Forces*, Vol. I, 170 pages, Boston, London and Paris, 1917; but has recently been extended in a series of papers on the *New Theory of Æther* just appearing in the *Astronomische Nachrichten*, the international journal of astronomy at Kiel, which is now in its hundredth year and 212th volume. As the *New Theory of the Æther* is a very extensive work of highly mathematical character, we are obliged to restrict the discussion to very simple outlines which will convey clear ideas to our minds.



1. The magnetic field of force and its effect upon, and the reaction between it and magnets adjacent to it. Decreased attraction in the left hand magnet, and increased attraction in the right hand one.



Enlarged view of one of the magnets assumed to be in the field of force, shown in the upper illustration immediately above the field.

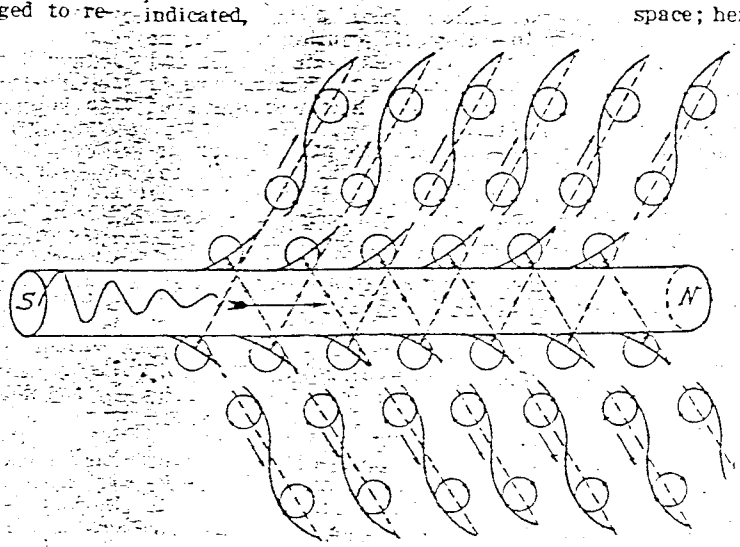
For a long time it has been known that all matter sends out a peculiar influence or *flux of energy*, which acts on other bodies; and ever since the publication of Sir Isaac Newton's *Principia*, 1687, it has been shown that all actions are mutual. Thus any influence exerted by one body on another will be based on the interactions of the two bodies, through the Etherial Medium enveloping both masses.

About 1850 it was discovered by the celebrated English electrician, Faraday, that all bodies are magnetic, but in varying degrees. Iron, steel and nickel are typical metals with strongly magnetic properties, and as far back as 1822 the celebrated French physicist, Ampère, explained magnetism by elementary electric currents circulating about the atoms. In the year 1917 the writer was able to show that this Ampère theory is identical with the modern wave-theory, in which the atoms are supposed to be vibrating and incessantly sending out waves through the surrounding aether.

and light. Accordingly, why may not these short waves correspond to parts of the longer waves of magnetism and of gravitation? Such was the question which has at length led to the very remarkable new theory of the ether, with simple and direct explanation of magnetism and electrodynamic action.

In the accompanying figure 1 we have outlined the body of a simple bar magnet, and also traced in detail the type of waves supposed to recede away from the magnet in the equatorial plane. It will be remembered that although the great mathematical physicist J. Clerk Maxwell was able to show that certain stresses are at work in the ether about a magnet, by which the lines of force tend to shorten themselves, he was unable to conceive of any physical cause for the action. Maxwell had not thought of waves of the type here imagined.

It is easily shown (cf. *Astron. Nachr.*, No. 5044, p. 54, May, 1920) that the *amplitude* of the waves follows the law here indicated,



2. The field of force surrounding a wire through which a current is passing, giving in diagram the effect upon the ether.

$$A = \frac{k}{r} \qquad (1)$$

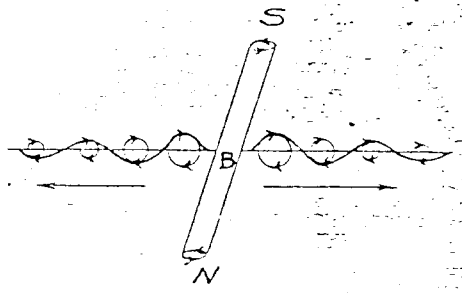
or varies inversely as the distance.

And it is proved in works on physics that the energy of the waves *is proportional to the square of the amplitude*, and thus the force they exert becomes simply:

This is the formula for gravitation, magnetism and similar forces which follow the law of the inverse squares.

Now it is very remarkable that the chief forces in nature vary inversely as the square of the distance. From this fact we know that if waves be the cause of the forces, the waves have to have amplitudes varying inversely as the distance, as shown in equation 1 above.

To deduce the law of the wave amplitude (1) in tridimensional space we proceed as follows: The displacement of any particle of a medium due to wave motion, of a given wave length, is independent of the periodic time; and since the oscillatory orbits of the particles are described in equal times, under continuous flow of the waves, these orbits will be proportional to the displacements or other homologous lines pertaining to the periodic paths of the particles. Let the velocities of the moving particles be v, and m their mass; then their kinetic energies will be represented by $1/2\ mv^2$. In the spherical expansion of the ether waves there will be no loss of energy in free space; hence on two successive sphere surfaces of thickness dr, the energies are equal, so that we have:



The other magnet on an enlarged scale, as shown to the right in the upper illustration.

$$4\pi r^2 \cdot \tfrac{1}{2} m v^2 = 4\pi r'^2 \cdot \tfrac{1}{2} m v'^2 \qquad (3)$$

or

$$v^2 : v'^2 = r'^2 : r^2 \qquad (4)$$

The kinetic energy of the vibrating molecules varies inversely as the square of the distance. But the velocity varies also as the amplitude, in simple harmonic motion; therefore, for the amplitudes A' and A'', corresponding to the radii r' and r'', we have by taking the square root in equation (4)

$$A' : A'' = r'' : r' \qquad (5)$$

$$A' = \frac{A'r'}{r''} = \frac{k'}{r''} \qquad (6)$$

Accordingly the amplitude or side displacement becomes

$$A = \frac{k}{r} \qquad (7)$$

as shown in the accompanying figure 1.

To understand the mechanism of magnetism, imagine waves receding away from the larger magnet, as shown in the diagram, and let the smaller magnet (B) present opposite poles. This corresponds to the case of attraction. The waves from the small magnet (B) rotate in the oppo-

[in]terpenetrate, they undo one another as far as possible at every point of the wave-[front].

Thus the larger waves tend to collapse when the smaller waves run through them; and this collapse or contraction gives rise to pulling. Such a *contraction* of the ether between the bodies is what we call *attraction*. The action when the ether contracts is like that of a stretched band of India rubber—it pulls the bodies together, by forces depending on the two magnets, their size and power, or degree of perfection of magnetization.

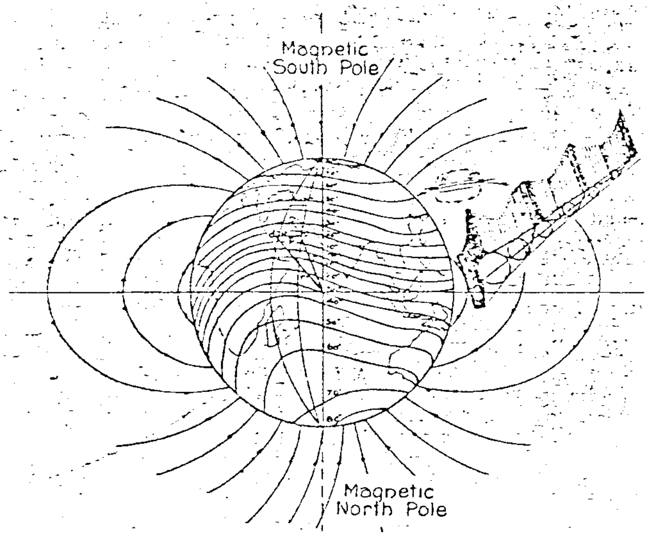
It is shown in the Wave-Theory (A. N. [?], p. 55) that the light travels 904,000 times faster than sound, from which it follows that the aether is 689,321,-000,000 times more elastic than air in proportion to its density. This number is enormous, and as the waves travel in free space with the velocity of light, and accumulate power by mere superposition, in proportion to the mass, or the number of atoms from which the waves proceed, we perceive that the action will depend directly on the mass, as in Newton's law of gravitation. Moreover, the intensity of the force will vary inversely as the square of the distance. This gives, therefore, a perfect explanation of the attraction of magnets which present opposite poles.

Let us now consider the cause of *repulsion*, when like poles are presented, which is exhibited in the second case on the right, in the same diagram. In this second case the waves from (B) rotate in the same sense as those from the larger magnet (A). When such waves interpenetrate, with the superposed rotations at every point in the same direction, one set of waves adds to the amplitudes of the other set: and the result is increased agitation of the ether, which thus tends to *expand* this medium between the two bodies. This expansive tendency of the ether thus gives rise to *repulsion*, and the magnets tend to push one another away. Thus we have a simple explanation of repulsion when like poles are presented.

Accordingly, we have a simple explanation of both attraction and repulsion, which no one has been able to devise heretofore. An explanation based on waves which is simple and direct has so much to commend it that we may pronounce it the true cause of the phenomenon. It thus appears as if we have at last discovered the cause of magnetism, and finally of electrodynamic action and universal gravitation.

An experiment by Dolbear (*Matter, Ether and Motion*, Boston, 1894, p. 85) throws great light on the tendency of Faraday's lines of force to shorten themselves.

"If a dozen disks five or six inches in diameter are set loosely an inch apart upon a spindle a foot long, so that they may be rotated fast, yet left free to move longitudinally upon the spindle, they will all crowd up close together as the pressure is less between them than outside. If one can imagine the spindle to be flexible and the ends brought opposite each other while rotating, it will be seen that the ends would exhibit an apparent attraction for each other, and, if free to approach, would close up, thus making a vortex ring, with the sections of the disks. If the axis of the disks were shrinkable, the whole thing would contract to a minimum size that would be determined by the rapidity of the rotary movement, in which case not only would it be plain why the ring form was maintained, but why the diameter of the ring as a whole should shrink. So long as it is rotated it would keep up a stress in the air about it. So far as the experimental evidence goes, it appears that a vortex ring in the air exhibits the phenomenon in question."



3. Magnetic field of the earth, showing how exactly it compares with the ether waves already illustrated and described

Now, according to the wave-theory, every line of force about a magnet is an axis of a rotating filament or ether vortex, and thus the lines of force tend to shorten themselves, as in Dolbear's experiment. The lines of force in the form of circles surround a wire bearing a current, which means that the wave rotations are flat in the planes passing through the axis of the wire. This arrangement is shown in figure 2. And as the magnet also sends out waves flat in the equatorial plane, at right angles to the magnetic axis, we see why a magnetic needle sets itself at right angles to the axis of the wire bearing the current, as first noticed by Oersted in 1819.

If we examine figure 2 we notice that the rotations in the waves above are opposite to the ones below. Hence, when two currents flow in the same direction the collapse of the ether waves between the wires causes the wires to attract, which conforms to observation. When the currents flow in opposite direction the rotations of the waves between the wires are in the same direction, and by the increase of amplitude thus arising, the ether expands itself, so that the wires repel, in accordance with observation.

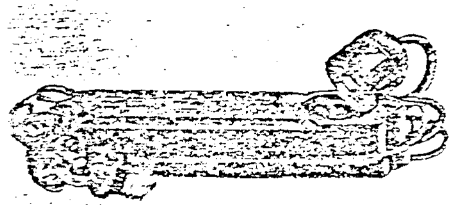
Accordingly, waves are the cause of electrodynamic action. It only remains to add figure 3, to illustrate the wave field of the earth's magnetism. It should be noted, as shown by Gauss, 1838, that the waves receding from the earth depend on 1/1380th part of the atoms of our globe. These atoms are lined up in parallel planes—the other 1379/1380ths being arranged with their planes lying haphazard, and producing the central action of gravitation.

With the rotations of their waves directed so as to harmonize mutually, the compass needle lies in the hollow of the receding earth waves, and thus pointing steadily to the Pole, guides the mariner safely over the trackless sea. This gives a very direct and simple explanation of the earth's magnetic field. The wave field about the globe is so very beautiful to behold that we cannot but regret it was not made known to us long ago. But who will show it to us?

Triplex Table-Tap

"TRIPLEX TABLE-TAP" is the name given to a new electrical appliance. The manufacturer claims that with this device any householder can wire his own furniture in a few minutes. It consists of a block of strong, black, fireproof composition, and carries three beveled tee-[slot outlets] countersunk holes at the ends. The device is sold, completely wired, with eight feet of silk covered cord, a motor plug, and a separable attachment plug which fits any lamp socket or convenience outlet.

This Triplex Table-Tap is backed with green baize and may also be used as a portable outlet, on tea wagons, side-boards and serving tables; or on the work bench, around the car, or wherever a convenient tee-slot electrical connection might be required.



Triple connection-block for use upon a table, so that by placing such block upon the table or fastening it to any part thereof, connections are supplied for three different articles.

[...] outlets [...] as well as

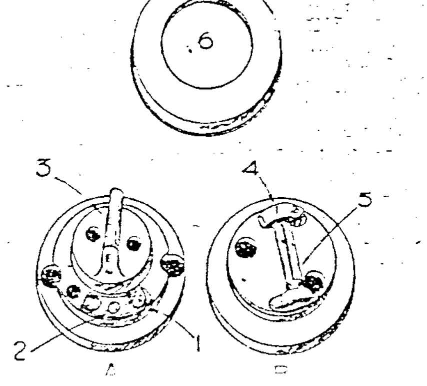
Economical Fuse Cutout

By Docteur E. DeBatz, Bordeaux, France

TAKE an old discarded switch (A). Remove the shaft and the contact spring. With strong scissors cut two strips of thin sheet brass and bend these with pliers as shown.

Insert these curved springs between the porcelain base and brass contact, and finally an automobile fuse is sprung in be-

(A) is the old switch; (B) is the fuse when finished; (C) is the porcelain cover.



ASTRONOMISCHE NACHRICHTEN

Band 211. Nr. 5044.

New Theory of the Aether. By *T. J. J. See.*

(First Paper.)

1. The Medium of the Aether is necessary for conveying Physical Action across Space.

A superfine medium associated with the stars and with the light of day, known as the Aether (*Αἰθήρ*), has been universally recognized since the time of *Homer* (Iliad, XV.20, and XVI.365). During the last three centuries the greatest natural philosophers and mathematicians, from *Huyghens*, *Newton*, and *Euler* to *Maxwell*, Lord *Kelvin* and *Poincaré*, have regarded this aetherial medium as a necessary condition for the action of physical forces across space. In his Mécanique Céleste 4.541, 1896, *Tisserand* expresses the general opinion thus:

»Les théories les plus récentes de la physique donnent lieu de croire que les attractions des corps célestes ne peuvent se transmettre à distance que par l'intermédiaire d'un milieu, sans doute l'éther. Mais on ne connaît rien encore sur ce mode de transmission. Il paraît probable que le même milieu sert de véhicule à des actions électriques ou électromagnétiques«.

Notwithstanding the very secure foundation for a valid theory of the aether erected by the labors of the most eminent geometers and natural philosophers since the age of *Newton*, a strange tendency has arisen within recent years, for abandoning the aether as an unnecessary hypothesis. Whether this reactionary tendency is based upon adequate grasp of the geometrical and physical considerations involved may be doubted by the more experienced natural philosophers of today. At any rate we leave this to the judgement of those investigators who follow the argument here developed.

In their treatise on Magnetism and Electricity, London, 1912, *Brooks* and *Peyser*, who were inspired by the electronic theories emanating from Cambridge, express themselves thus:

»In this book, we have implicitly assumed the existence of a medium, which is the seat of the phenomena denoted by the terms electric and magnetic lines of force. It may, however, be mentioned that at the present moment the various questions associated with the ether give rise to problems of great complexity and difficulty. The experimental knowledge acquired during the last twenty years, taken in conjunction with recently acquired knowledge regarding the ‚electron' and the constitution of matter, leads to apparently irreconcilable results, and the real nature of the ether — if it exists at all in the old sense of the word — must be regarded as absolutely unknown. For instance, if the ether is incompressible, as it is usually assumed to be, we are driven, by one line of argument, to the conclusion that it is 2000 million times denser [1]) than lead and possesses enormous energy of internal motion. On the other hand, if it is compressible, it may be much rarer than the rarest gas. There is no intrinsic difficulty in either view, but at present no method is known by which we may hope to discriminate between them. The whole subject of the ether is in that state of uncertainty and apparent confusion, which in other branches of science has usually preceded some great advance in knowledge«.

Such an attitude as the above, by physicists of recognized authoritative connections, is confusing enough; but an even more bewildering doctrine has been put forth by *Einstein*, and quite widely adopted in England, though it generally is rejected in America. The english observers of the total solar eclipse of May 29, 1919, found some evidences of a deflection of the light of stars by the field of the sun, but it was by no means conclusive, and the weakness of the whole Theory of Relativity was impressively pointed out by Dr. *Silberstein*, (Observatory, November 1919, p. 396-7), who showed that *Einstein*'s theory will not account for the refinement of moving perihelia, and would even permit a planet or comet to move in a straight line, under the gravitative action of the sun. In view of these facts Dr. *Silberstein* justly says that the *Einstein* theory stands or falls by the *Evershed* and *St John* spectral observations, which are ample, yet do not confirm the theory.

In an interview at Chicago, Dec. 19, 1919, Professor *A. A. Michelson*, the eminent authority on light, openly rejects *Einstein*'s theory, because it does away with the idea of light traveling by means of vibrations in the aether which is supposed to fill all space. »*Einstein* thinks there is no such thing as aether«, remarked *Michelson*. »He does not attempt to account for the transmission of light, but holds that the aether should be thrown overboard«.

In view of the confusion of thought introduced by the electronists, on the one hand, and by the *Einstein* pure mathematicians, on the other, — both extremes leading to ideas not appropriate to the facts, which Dr. *Whewell*, History of the Inductive Sciences, 1847, 1.81, showed was the cause of the failure of the physical sciences among the greeks — it seems highly important to enter upon an account of certain unpublished researches on the aether made by the present writer during the past six years, omitting so far as possible the results already available in volume I of the Electrodynamic Wave-Theory of Physical Forces, Boston, London and Paris, 1917.

And first we shall show that the aether is necessary for holding the planets in their orbits, from the established law of the centrifugal force. This centrifugal motion must be counteracted, otherwise a planet can not be made to curve the path at every point and thus revolve in a Keplerian ellipse with the sun in the focus.

[1]) In a future paper a conclusive criterion will be given for rejecting this claim of a large density for the aether.

It is well known that the centrifugal force is given by the expression, $f = mv^2/\varrho$ (1)

where m is the revolving mass, v is the instantaneous velocity, and ϱ the radius of curvature of the orbit. As the planetary orbits and the orbit of the moon are not far from circular, we may with sufficient approximation calculate the centrifugal force for circular orbits.. In the case of the earth's attraction for the moon, it suffices to take the earth's weight in metric tons, the moon's mass = 1/81.45, and the distance of the moon 60 terrestrial radii, so that the weight at the earth's surface is to be reduced by the divisor 3600. Then, as gravity balances this centrifugal force, we have for the attraction of the earth on the moon:

$$f = (5.956292 \times 10^{21})/(81.45 \times 3600)$$
$$= 20.3137 \times 10^{15} \text{ metric tons.} \quad (2)$$

This enormous tension would require for its support the full breaking strength of a weightless solid circular column of steel 645 kms in diameter, when the steel has the tensile strength of over 30 metric tons to the square inch = 6.4 sq. cms, and such a small bar of steel would thus about lift a modern battleship of the largest type. The tensile strength of the above single column, 645 kms in diameter, would be equivalent to about 5000000000000 columns of such weightless steel, each of one square foot cross section, 922 sq. cms, or about one such column to each area $16 \times 16 =$ 256 sq. feet of a hemispherical cross section of the earth. So much for the stresses which control the moon's motion.

But the gravitational attraction of the sun upon the earth is very much more powerful than that of the moon. The attraction of the sun upon the earth is of course equal to that of the earth upon the sun, which is easily seen to be

$$f = 332750/(23445)^2 \times 5.956292 \times 10^{21}$$
$$= 3.60572 \times 10^{18} \text{ metric tons} \quad (3)$$

where the number 332750 represents the sun's mass, in units of the earth's mass, and 23445 is the sun's mean distance, in units of the earths radius.

This attraction of the sun on the earth is equivalent to the tensile strength of 100000000000 weightless circular pillars of steel, like that discussed above, but each having a diameter of 30 feet, about 9 metres. This is equivalent to the tensile strength of a forest of weightless steel pillars, each 11 inches or 28 cms in diameter, on each square foot of a hemispherical cross section of the earth; so that the surface of the globe would be almost covered with these cables of steel.

Such calculations of the enormous gravitative power of the heavenly bodies were first brought to my attention by Professor *Joseph Ficklin*, of the University of Missouri, about 33 years ago, and have never been overlooked in my subsequent studies of the cause of gravitation. Now with these concrete figures before us, we see that the cause assigned for gravitation must be adequate to sustain these tremendous forces, miraculously pulling like stupendous cables of steel, imagined as weightless as spider webs, yet stretched to the utmost limits of their tensile strength across the celestial spaces, for holding the planets in their orbits.

Accordingly *Einstein*'s proposal to do away with the aether is chiefly remarkable for the lack of understanding of the physical universe which it displays. Sir *Isaac Newton* himself denounced those who believed action could occur across empty space as not having a competent faculty of thinking in philosophical matters. In his letter to *Bentley*, 1692-3, Febr. 25, he says:

»That gravity should be innate, inherent and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers«.

In a paragraph cited below, *Maclaurin* tells us that *Newton* held gravitation to be due to impulses of the aether, but could not make out exactly how they arose; and this passage shows that *Newton* did not regard this medium as ordinary material.

a) It is shown below that the elasticity of the aether is 689321600000 times greater than that of our air in proportion to its density: it has therefore enormous power of contraction, if any natural process be at work to cause it to collapse.

b) It is shown in the Electrodynamic Wave-Theory of Phys. Forc. I, 1917, that between any two sources, as the sun and earth, the waves so interpenetrate, with rotations in opposite directions, as to decrease the stress and cause collapse of the medium between the sun and the earth; and this therefore develops an enormous tension, with maximum stress in the right line between the bodies, while beyond them there is corresponding increase of stress and thus an external pressure also overcoming the effects of the centrifugal force, and compelling the planet to follow the Keplerian ellipse about the sun in the focus.

c) It is shown in section 7 below, that the potential is simply an expression for the total accumulated stress, due to the waves from all the individual atoms of a body, — each wave following the law of amplitude,

$$A = k/r \quad (4)$$

and giving an element of force, as in gravitation,

$$f = k^2/r^2 . \quad (5)$$

Accordingly we see that *Laplace*'s definition of the potential, 1782, points directly to the wave-theory:

$$V = \iiint \{\sigma / \sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}\}\, dx\, dy\, dz . \quad (6)$$

d) Therefore it is natural to hold that gravitation is a wave phenomenon in the aether, and to dismiss all other hypotheses as not fulfilling conditions essential to a true physical cause. This wave-theory of gravitation will give a new ground for the deflection of the light of stars when the paths of their rays pass through the gravitational field of the sun, as indicated in the eclipse of May 29, and reported at the meetings of the Royal Society and Royal Astronomical Society, Nov. 6, 1919.

e) It will be shown below that both the density and rigidity of the aether increases as we go outward from the sun, according to the laws

$$D = \nu r \quad E = \nu' r . \tag{7}$$

Accordingly the velocity of the waves remains approximately constant, (Electrodynamic Wave-Theory of Physical Forces I.14–157, 1917)

$$V = C\sqrt{(E/D)} = C\sqrt{(\nu' r/\nu r)} . \tag{8}$$

But experience alone can determine whether this condition holds with geometrical rigor, or whether along the actual path, containing diffuse coronal matter, the stationary condition,

$$\delta \int ds = 0 \tag{9}$$

may not lead to a small deflection of the original path of light.

f) Such an increase of density in the aether, as we recede from the sun was suspected by *Newton* in 1721, (3rd edition of Optics, p. 325). It is of authentic record that *Newton* believed gravitation arises from the impulses of a subtile aethereal medium, but he »was not able, from experiment and observation, to give a satisfactory account of this medium, and the manner of its operation, in producing the chief phenomena of nature«, (*Maclaurin*, Account of *Newton*'s Philosophical Discoveries, London, 1748, p. 111), and thus he left the problem of the cause of gravitation to future investigators.

g) The observed deflection of the rays of stars passing near the sun, amounting to about 1″.75, may be most naturally explained by the action of the gravitational and magnetic wave-fields, under the influence of coronal matter, varying as the inverse fourth power of distance, and the arrangement of the density and rigidity of the aether, near the sun. An arc of 1″ at the sun's mean distance corresponds to an absolute space of 725 kms, 1″.75 to 1269 kms. In the presence of the sun's strong gravitational and magnetic fields, and the magnetized faint coronal matter pervading that wave-agitated region, it is probable that a central refraction or deflection of the light, of this magnitude, somewhat analogous to an unsymmetrical *Zeeman*-effect, may be anticipated. The rotation of the beam of polarized light by magnetism, in *Faraday*'s experiment of 1845, would lead us to expect some action in the sun's coronal wave-field.

h) As *Einstein*'s predicted displacement of the spectral lines towards the red could not be confirmed by *Evershed* and *St John*, who had ample telescopic power to make this shift-effect at least 50 times the probable error of their measures, it cannot be presumed that the deflection of star-light passing near the sun is a confirmation of a purely mathematical theory. The deflection of the light must rather be explained by the physical properties of the aether, interspersed with faint coronal matter, varying as the inverse fourth power of the distance, in the region of intense wave-agitation about the sun.

i) At the joint meeting of the Royal Society and Royal Astronomical Society, Nov. 6, 1919, no one attempted to answer the weighty objections brought forward by Dr. *Silberstein*, who had made a careful study of *Einstein*'s theory, and thus pointed out the bizarre conclusions drawn by some pure mathematicians who are prone to forget that the deflection of starlight near the sun is as purely a physical problem as the refraction of light in the earth's atmosphere. Now the sun's deflection of light is similar to refraction, but very minute, — half of it being 0″.875, as against 2000″ in our atmosphere, or about 2300 times smaller.

j) Since, according to the report of the observers of the eclipse of May 29, 1919, this minute deflection disappears, when the sun moves out of the path of the light from the stars lying behind it, such a temporary effect cannot properly be attributed to »a warp of space«, but only to the refractive action of the sun's envelope. When *Newton* observed the refraction of light by a prism he had no thought of attributing the effect to »a warp of space«; and one cannot but reflect how fortunate it is that the physical theory of astronomical refraction was perfected by *Newton*, *Laplace* and *Bessel* before such confusing terms as »fourth-dimension-time-space-manifolds« were introduced into science.

k) It cannot be held that *Einstein*'s theory enlightens us on the motion of mercury's perihelion, because at least half a dozen explanations, some of them approved by *Newton*, *Hall*, *Newcomb* and *Seeliger*, are already known; and another simple one, involving no mysticism and no rash assumptions, but following from definitely established physical laws, will be brought out in the present investigation.

2. New Law of the Density and Rigidity of the Aether.

To deduce the law of the wave amplitude (4) in tri-dimensional space, we proceed as follows. The displacement of any particle of a medium due to wave motion, of a given wave length, is independent of the periodic time, and since the oscillatory orbits of the particles are described in equal times, under continuous flow of the waves, these orbits will be proportional to the displacements or other homologous lines pertaining to the periodic paths of the particles. Let the velocities of the moving particles be v, and m their mass; then their kinetic energies will be represented by $\frac{1}{2} m v^2$. In the spherical expansion of the aether waves, there will be no loss of energy in free space; hence on two successive sphere surfaces of thickness dr, the energies are equal, so that we have:

$$4\pi r^2 \cdot \tfrac{1}{2} m v^2 = 4\pi r'^2 \cdot \tfrac{1}{2} m v'^2$$

or

$$v^2 : v'^2 = r'^2 : r^2 . \tag{10}$$

The kinetic energy of the vibrating molecules varies inversely as the square of the distance. But the velocity varies also as the amplitude, in simple harmonic motion: therefore, for the amplitudes A' and A'', corresponding to the radii r' and r'', we have by taking the square root in equation (10)

$$A' : A'' = r'' : r' \tag{11}$$

$$A'' = A' r'/r'' = k''/r'' \tag{12}$$

Accordingly the amplitude or side displacement becomes,

$$A = k/r . \tag{13}$$

And

$$V = M/r =$$

$$= \iiint \{\sigma / V[(x-x')^2+(y-y')^2+(z-z')^2]\}\, dx\, dy\, dz \tag{14}$$

which is the law of the potential first used by *Laplace* in 1782. Thus it appears that if there be aether waves propagated outwardly from any molecule of matter, the amplitude, or maximum displacement of the oscillating particles of the aether, will vary inversely as the radius of the spherical wave-surface.

A partial development somewhat like this is given in certain treatises on physics, such as *Wüllner*'s Experimental Physik, 1.784, and *Mitchie*'s Elements of Wave Motion, p. 11, but no importance is attached to the result, as in my Electrodynamic Wave-Theory of Physical Forces, 1.14–157, 1917. So accurately is this true, that when I brought this simple formula for the wave amplitude, $A = k/r$, before the Academy of Sciences of St. Louis, in a public address, Sept. 21, 1917, great surprise at the simplicity of the formula was expressed by such experienced investigators as Professor *F. E. Nipher*, and President *E. A. Engler*. Thus it is necessary to develop the subject a little more fully in the present paper, since no adequate discussion of the problem appears to be available in existing works on physical science.

Let us now consider the arrangement of the density of the aether about the sun.

1) Suppose we consider carefully the amplitude of the waves from the sun in any solar spectral line, such as that of sodium, *D*. It is evident that if we disregard all other radiations, and fix attention upon this sodium light alone, then as the wave amplitude varies inversely as the distance from the sun's centre, this amplitude of our vibrations constituting sodium light will be 219 times greater at the sun's surface than at the surface of the earth — since the earth's mean distance is 219 solar radii.

2) Similar reasoning will hold for the waves of light of the spectrum of such elements as strontium, barium, boron, calcium, hydrogen, carbon, iron, nickel, cobalt, copper, titanium, etc. Thus all the light waves of all elements conform to the law: $A = k/r$.

3) All these chemical elements also radiate heat waves which follow the same law of amplitude. And for both light and heat the above law holds rigorously true. If there be any other type of waves in the aether, the same law will hold for these undulations also.

4) Now magnetism and gravitation have been referred to electrodynamic waves, in the author's work on physical forces, 1917. If these waves exist, they also will follow the same law $A = k/r$; and, that they do exist is shown by a variety of phenomena, which admit of no other interpretation. For example, the electrodynamic action of a current of electricity is due to waves: thus arise electrical forces: also magnetic forces, gravitational forces, etc.

5) Gravitation admits of no other explanation, while on this explanation we have an immediate insight into the fluctuations of the moon's mean motion, which so long proved utterly bewildering to astronomers. And there must be not only a cause of gravitation, but a simple one, harmonizing with electrodynamic action, in the generation of electrical forces, magnetic forces, etc. The electrodynamic wave-theory alone fulfills this necessary and sufficient condition, for the following special reason.

6) The aether is shown to have an elastic power 689 321 600 000 times greater than that of our air in proportion to its density. Hence it will have practically unlimited power of contraction, and thus be able to generate the stupendous forces required for holding the planets and stars in their orbits.

7) But this will be possible only if the aether is arranged according to the law of density $\sigma = \nu r$; which in turn will follow if electrodynamic waves recede from the sun, having amplitudes $A = k/r$. For the amplitudes increasing towards the sun's centre insures a decrease of density of the aether about that centre, owing to the increasing wave-agitation near the sun's surface.

8) Now all these mutual arrangements, favorable to the wave-theory, would not exist, unless that theory represented a law of nature. Because not only are all facts of the aether harmonized, but also all the forces brought under the principles of the conservation of energy, and of least action. Thus nature not only acts simply, but also by the most uniform processes throughout all space. It is not therefore admissible to hold any theory of the aether other than that it is an infinite aeolotropic elastic solid, with the density arranged about the heavenly bodies to increase directly with the distance. And the wave amplitudes varying inversely as the radius, $A = k/r$, supports this theory, by geometrical considerations, which exclude every other theory of the medium for the interpretation of the forces operating throughout the physical universe.

9) In the course of the article Aether (Encyclopedia Britannica, 9th. ed., 1877), *Maxwell* calculates the density as $\varrho = 1.07 \times 10^{-18}$, thus implying homogeneity, and speaks of this medium as »a vast homogeneous expanse of isotropic matter.«

But it is obvious on reflection that this medium cannot be homogeneous[1]); for in that case there would be no stresses in the medium for generating the forces which govern the mutual interaction of bodies throughout space. The mutual actions between bodies is an observed fact. In motion the bodies are everywhere found to describe ellipses, parabolas or hyperbolas about one another. Nothing but forces, due to tension between the bodies, and increase of pressure beyond them, could possibly produce this remarkable power for holding the planets in their orbits.

10) Thus forces imply waves, and waves lead to forces, when the mutually interpenetrating waves are so directed as to undo one another, and cause the collapse of the medium in the right line between the bodies. As the gravitational forces are of enormous intensity, it follows that the elastic power of the aether has to be tremendous, in order to generate the forces actually observed.

11) Accordingly, the existence of forces implies stresses in the aether: the stresses imply waves: the waves imply heterogeneous density in the medium, which must vary with the radius from any mass according to the law $\sigma = \nu r$. There is no other view of the aether which can be held. Homogeneity of density would imply no stresses; no stresses would imply no forces; no forces would imply an inert universe; which is contrary to observation and thus wholly inadmissible.

[1]) In the Baltimore Lectures, 1904, p. 265, under date of Nov. 16, 1899, Lord *Kelvin* says: »We have strong reason to believe that the density of ether is constant throughout interplanetary and interstellar space«. This error is very widespread, and its persistence shipwrecks physical research!

12) The aether is therefore arranged about the sun with the density following the law, $\sigma = \nu r$, which results from wave-agitations having amplitudes, $A = k/r$. The energy of the forces generated by these waves is proportional to the square of the amplitude, and therefore we have for the force,

$$f = k^2/r^2 \qquad (15)$$

which explains all the observed effects of gravitation, magnetism, etc.

13) Now quite aside from the simplicity and continuity of the process of reasoning here outlined, it remains a fact that the wave-theory is adequate to explain all the observed phenomena of nature. The simple law of density of the aether here imagined may therefore be admitted to really pervade the universe. So far from being homogeneous, the aether is really very heterogeneous. Indeed, it is a gas, behaving as an elastic solid — an infinite aeolotropic elastic solid — fulfilling the law of density, $\sigma = \nu r$, and of wave amplitude, $A = k/r$, and therefore yielding forces following the law, $f = k^2/r^2$, as required by *Newton* in 1721, for explaining the cause of universal gravitation.

At the earth the density of the aether is 219 times what it is at the sun's surface, because the earth's mean distance is 219 times the solar radius. But *Newton*'s formula for the velocity,

$$V = C\sqrt{(E/D)} \qquad (16)$$

would give a change of velocity if the density alone increased, while the elasticity E remained constant.

Now the velocity of light across the planetary spaces was originally found by *Römer*, 1675, from the eclipses of Jupiter's satellites, and subsequently confirmed by the elaborate researches of *Delambre*, on the motions of these satellites (cf. C. d. T. 1788, and Astronomie Théorique et Pratique, 1814). By discussing a thousand eclipses of the 1st satellite *Delambre* fixed the constant of aberration at 20″255, while *Michelson*'s velocity of light, near 300 000 kms., and the solar parallax 8″80 makes the aberration about 20″48.

Thus V is about the same for the aether across the diameter of the earth's orbit, and for the aether of the terrestrial atmosphere, in which the velocity has been investigated experimentally by *Cornu*, *Michelson*, *Newcomb* and others.

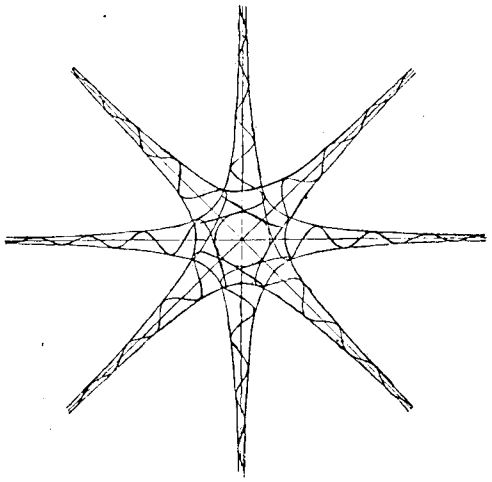


Fig. 1. Diagram showing graphically the decrease of the density of the aether towards the sun, owing to the asymptotic increase in wave amplitude.

Accordingly, this observational fact requires us to hold that E increases in about the same ratio as D, so that our law of V for the heavenly spaces becomes,

$$V = C\sqrt{(\nu' r/\nu r)} \qquad (17)$$

and therefore $E = \nu' r$. Thus both the elasticity and rigidity of the aether increase directly as the radius from the sun, or other heavenly bodies.

The reason for this remarkable law is this: namely, the viscosity of a gas depends upon the friction of the molecules projected from one layer of gas into the adjacent layer, and vice versa. In the case of the aether the viscosity becomes rigidity. And with the increase of the density of the aether particles there should be more molecules projected into the adjacent layers mutually, by the ordinary kinetic exchange, in strict proportion to the density. Thus the rigidity of the aether increases directly as the density, as in the above formula.

It may be noted that by the formula of *Newton*, an increase of the density by the factor 219, without change in E, would lead to a reduced velocity of only about $^1/_{15}{}^{\text{th}}$ of the original. No such enormous difference, in the velocity of light as determined by observations of Jupiter's satellites, and that found by terrestrial experiments, is admissible; and thus the above law of rigidity of the aether is approximately verified by the comparison of celestial and terrestrial observations. But a more exact test of the value of V, from eclipse observations of Jupiter's satellites, taken as directly as possible across the diameter of the earth's orbit, for comparison with the experimental value found by *Michelson*, is highly desirable.

3. The Relation between the Mean Molecular Velocity of a Gas and that of a Wave transmitted in such a Medium.

The Philosophical Magazine for June and September, 1877, contains two important articles on the theory of gases by Dr. *S. Tolver Preston*, and also notes on the conclusions then reached by the celebrated Professor *J. Clerk Maxwell*, with whom *Preston* was in correspondence. In the first of these papers, p. 452, § 19, *Preston* reaches the following remarkable conclusion: »That the velocity of propagation of a wave (such as a wave of sound) in a gas is solely determined by, and proportional to, the velocity of the molecules of the gas; that this velocity of propagation of the wave is not affected by density, pressure, or by the specific gravity of a gas, or by anything else excepting the velocity of its molecules«.

In the second Postscript, p. 453, *Preston* states *Maxwell*'s conclusion as follows:

»Professor *Clerk Maxwell*, to whom this paper was communicated, and who has taken a kindly interest in the subject, has worked out mathematically the velocity for a wave or impulse propagated by a system of particles moving among each other according to the conditions of equilibrium investigated in the first part of this paper — the diameter of the particles being assumed so small as to be negligible compared with their mean distance, and the particles being further assumed spherical, so that there is no movement of rotation developed at the encounters (which would involve loss of velocity)«.

5

»Under these premises, the velocity of the wave was found to be $^1/_3 V5$ (or 0.745) into the mean velocity of the particles. In most gases the velocity of sound is slightly less than this. This is referable to the movements of rotation developed at the encounters of the molecules (which calculably would delay the wave to a certain extent). In vapour of mercury, according to the determinations of *Kundt* and *Warburg*, the velocity of sound is exactly $^1/_3 V5$ into the molecular velocity«.

According to these announcements, the corpuscles of the aether, viewed as a monatomic gas, should have a mean molecular velocity of $3/V5 \cdot V = 1.34\,V$, where $V = 3 \times 10^{10}$ cms, the velocity of light. A conclusion of such great importance, which received the approval of the luminous mind of *Maxwell*, is entitled to profound attention. Thus I have had it before me for some five years, but only undertook the mathematical verification and physical test of this *Preston-Maxwell* theorem quite recently; and, as my results differ slightly from those of *Preston* and *Maxwell*, I will give the process of test and verification employed.

In order to confirm this theory I have compared the observed velocity of sound for the four leading gases which are best determined, with their mean molecular velocities, and find the following indications of experiment, without regard to the *Preston-Maxwell* theory. In the experimental data there remains a little uncertainty. For the older values of v and k_2 the table yields for the corrected ratio a mean of 1.64, which is 0.07 above the theoretical value of 1.57. The newer data, preferred by *Jeans*, Dynamical Theory of Gases, 2nd edition 1916, p. 9–131, give a mean value of 1.57, though the discordance between the results for the individual gases is somewhat increased.

Gas	Mean molecular velocity v		Observed velocity of sound in gas at 0° C V	Ratio v/V without correct.		Correction factor for $\sqrt{(k_1/k_2)}$ *)		Corrected ratio v/V	
	older values	newer values		older values	newer values	older values	newer values	older values	newer values
Air	498 m	459 m	332.0 m	1.50	1.38	1.09	1.09	1.63	1.51
Hydrogen	1859	1694	1265.0	1.47	1.34	1.09	1.09	1.60	1.46
CO	497	493	337.1	1.50	1.46	1.10	1.09	1.65	1.59
CO_2	396	393	259.4	1.52	1.51	1.10	1.13	1.67	1.71
Mean value for a monatomic gas:								1.64	1.57

*) $k_1 = 1.66$ for a monatomic gas; $k_2 = 1.40$ for a biatomic gas like the air or hydrogen; $k_2 = 1.36$ for *CO* and CO_2 in the older values. But in the newer values air, hydrogen and *CO* have $k_2 = 1.40$, and CO_2 has $k_2 = 1.30$, from the data given by *Jeans*.

It thus appears from the most reliable data available that the ratio should be larger than *Maxwell* indicated by about 17 %. His processes of calculation are not known, but a theoretical ground for the above result may be deduced as follows. Consider the particles of a monatomic gas to move with the velocity v, as in the reference circle, in simple harmonic motion, while the wave advances across the diameter of the circle with the velocity V. Then it is evident that the two motions are in the ratio of π to 2, which gives 1.5707963, in exact agreement with the above value as corrected for a monatomic gas.

This theoretical and practical conclusion is confirmed also by the profound researches of *Airy* on Tides and Waves, Encyclopedia Metropolitana, 1845. In Plate I, fig. 27, we find a very exact representation of the motions of the elements which go to make up the form of a wave in water. As the wave advances these elements describe small circles about a mean position, while the forward and backward motion incident to the passing of the wave is over two diameters of the elementary circles, giving the obvious ratio $2\pi/4 = 1.57$, as before. It was from the study of *Airy*'s researches that I became doubtful of the numerical accuracy of *Maxwell*'s result, and was led to subject the theory to a practical as well as a theoretical test.

If therefore light be observed to have a velocity of 300000 kms per second, the particles of the aether will have an average molecular velocity of 471239 kms per second. This is a very important result, and it confirms the general theory outlined by *Preston* and *Maxwell*, though the details of their processes are altered.

4. Exact Calculation shows the elastic power of the aether to be 689321600000 times greater than that of our air in proportion to its density: Thus it cannot be disrupted by any known force, and only the quick action of dynamite will generate waves in it.

In the »Electrodynamic Wave Theory of Phys. Forc.«, I, 1917, the writer has referred the chief forces of nature to wave action, and explained the mode of wave action for gravitation, magnetism, electrodynamic action, etc. As the aether was taken to be corpuscular, yet known to behave like an elastic solid, owing to the enormous velocity of the particles, the elasticity was recognized to be adequate to produce the postulated dynamical effects, but it is highly desirable to have this working hypothesis for so important a constant verified by exact calculation.

In the passage above cited from the Optics, 1721, p. 325, *Newton* gave the first outlines of a correct theory of the elasticity of the aether. It was subsequently rediscussed by Sir *John Herschel*, in the well known address on light, (Familiar Lectures on Scientific Subjects, London, 1867, p. 282); yet owing to the importance of an understanding of the elasticity of the medium for the Electrod. Wave-Theory of Phys. Forc., I have reexamined the whole subject. The present results establish beyond doubt the almost infinite power of expansion and contraction always operating in the aether for generating the stupendous physical forces observed throughout nature.

It is therefore certain that wave action in such an elastic medium is adequate to account for all the varied

operations of the physical universe. Moreover, since light, heat, chemical affinity, etc., have long been referred to such waves in the aether, the more general electrodynamic wave-theory thus gives complete continuity to our theories of physics, thereby confirming the correlation of all natural forces, and giving new physical grounds for the doctrine of the conservation of energy.

In the closing paragraph to his celebrated Treatise on Electricity and Magnetism, 1873, *Maxwell* justly says that »whenever energy is transmitted from one body to another in time, there must be a medium or substance in which the energy exists after it leaves one body and before it reaches the other«. This also points to wave action, such as *Gauss* was considering in 1835, and of which *Weber* gave the fundamental law in 1846, *Newton*'s law of 1686 being a special case corresponding to circular orbits.

In the Principia, Lib. 2, Prop. 48, Sir *Isaac Newton* deduces the formula for the velocity of waves or pulses propagated in an elastic medium, such as waves of sound in the air, $V = C\sqrt{(E/D)}$.

This is now written

$$V = \sqrt{\{(k g h \sigma/D)\cdot(1+\alpha t)\}} = 331.76\,\mathrm{m}\,\sqrt{(1+0.003665\,t)} \qquad (18)$$

where t is the temperature; α is a coefficient, 0.003665; g = acceleration of gravity, 981 cm; h = normal barometric pressure, 76 cm; σ = 13.6, density of Mercury; D = the density of air, 0.001293; and k = 1.4050 (cf. *Wüllner*'s Experimental Physik, 3.552) is the ratio of the specific heat of air under constant pressure to that under constant volume, introduced by *Laplace* for harmonizing *Newton*'s theoretical formula with the observed velocity of sound in air.

In many investigations it is possible to determine the velocity with which waves are propagated, but it is not always possible to determine independently the elasticity or density of the medium — we can only find the ratio E/D. This is partly true of the aether, for example, which transmits light waves or electrodynamic waves with the speed of 300000 kms per second, but gives no process of fixing the elasticity of this medium except by an independent calculation of the density, which, however, may be made by the process first used by Lord *Kelvin* in 1854, (Baltimore Lectures, 1904, p. 261–263), and afterwards adopted by *Maxwell*, Scientific Papers, 2.767.

In section 5 below we find, by the process here described, that at the sun's surface the density of the aether is $\varrho = 2\times10^{-18}$ and the rigidity 1800. Using these constants in *Newton*'s formula, we may verify the observed velocity of wave propagation:

$$V = \sqrt{(n/D)} = \sqrt{\{1800/(2\times10^{-18})\}} = 30000000000\,\mathrm{cms} = 3\times10^{10},$$ the velocity of light.

To compare a perfect monatomic gas like the aether with diatomic gases like the air, we use the formula for the velocity of sound:

$$V = \sqrt{\{(g h \sigma/D)\cdot k\cdot(1+\alpha t)\}} = \sqrt{[(9.808\times0.76\times13.59/0.001293)(1.405)(1+\alpha t)]} = 331.8\,\mathrm{m}\,\sqrt{(1+0.003665\,t)}\ \text{at}\ t^\circ\,\mathrm{C}. \qquad (19)$$

This shows that the velocity of light is 904268 times swifter than sound. Squaring this number, and dividing the result by $1.666/1.405 = 1.18624$ we get the immense number 689321600000; which shows how much the elasticity of the aether, regarded as a monatomic gas, exceeds that of the air in proportion to its density[1]). In the Optics, 3rd edition, 1721, p. 326, *Newton* makes this number 490000000000, which is 71 per cent correct.

In view of this excessive elasticity of the aether, in proportion to its very small density, compared to that of air, we can understand the almost inconceivable velocity of light. It is also necessary to bear in mind this enormous elasticity in order to understand why the aether is practically incompressible. When a wave begins to be generated, the disturbance is propagated away so rapidly that the wave amplitude necessarily is small compared to the wave length. In the calculations of section 5 we have taken the wave length as 101.23 times its amplitude, which *Maxwell*, Lord *Kelvin* and *Larmor* consider a safe basis in all numerical determinations.

The incompressibility of the aether is due to the very high mean velocity of the aether corpuscles, 471239 kms per second, and their enormously long free path, 572959 kms: which makes the medium behave as an elastic solid for quick acting forces, but enables the corpuscles to move out of the way of the swiftest planets with a 10000-fold greater speed. Owing to its enormous elasticity, the aether instantly adjusts itself to any state of steady motion, and thus this medium offers no resistance whatever to uniform celestial motions.

This circumstance fully explains a grave difficulty which has been felt from the age of *Newton*, and hitherto appeared utterly bewildering to natural philosophers. In connection with such extraordinary physical conditions in the medium, it may be useful to recall an account of the interior constitution of the sun given by Professor *Newcomb* in the Encyclopedia Americana, 1904:

»Yet another unknown factor is the temperature of the interior, ... it may be 1000000 degrees. As the highest temperature which it is possible to produce artificially probably does not amount to 10000 degrees, it is impossible to say what effect such a temperature would have upon matter. Thus we have two opposing causes, the one an inconceivable degree of heat, such that were matter exposed to it on the surface of the earth, it would explode with a power to which nothing within our experience can be compared, and a pressure thousands of times any we can produce, tending to condense and solidify this intensely heated matter. One thing which we can say with confidence as to the effect of these causes is that no chemical combinations can take place in matter so circumstanced. The distinction between liquid and gaseous matter is lost under such conditions. Whether the central portions are compressed into a solid, or remain liquid, it is impossible to say.«

[1]) In his thoughtful Familiar Lectures on Scientific Subjects, 1867, p. 282, Sir *John Herschel* gives this figure as 1148000000000; but he omits altogether the ratio 1.66 which applies to the aether as a monatomic gas. This correction is verified both by theory and by observation on such monatomic gases as Mercuryvapor, Helium, Argon, Krypton, Neon, Xenon.

In the writer's Researches on the Physical Constitution and Rigidity of the Heavenly Bodies, 1904–5, he reached the conclusion that the confined solar matter must necessarily be gaseous, though acquiring the property of a highly rigid solid under the enormous pressure and high temperature to which the matter is subjected. In fact it was found by calculation that the layers of the sun's globe have an average rigidity of over 2000 times that of steel, (AN 4104, equation 22, p. 384), while the average rigidity of the matter, accumulated with increasing density in the interior layers, may be 6000 times that of Nickel steel (AN 4104, equation 38, p. 392).

Such a globe must be viewed as bursting internally with pent up explosive energy, yet kept in equilibrium by the accumulating pressure of the surrounding layers: the confined matter is gaseous, yet rigid to the highest degree, and in such confinement must have the property of a solid of enormous rigidity.

Now the rigidity of the aether is variable with the radius vector drawn to the sun's centre, but generally less than that of solids such as glass, which is about 10^{11}. Yet with such high elasticity, due to the enormous molecular velocity 471239 kms, we see that it cannot be rent or cracked, as Lord *Kelvin* once suggested, (Popular Lectures and Addresses, 1.336), by any forces at work in nature. The only artificial forces yet found capable of setting up waves in the aether were the extremely quick explosions of dynamite used by Professor *Francis E. Nipher* of St. Louis.

5. Table of the Physical Constants of the Aether.

The general method employed for determining the physical constants of the aether is based on the process for calculating the mechanical value of a cubic mile of sunlight devised by Lord *Kelvin*, 1854, and first published in the Transactions of the Royal Society of Edinburgh, (cf. »Mechanical Energies of the Solar System«, 1854, and Baltimore Lectures, 1904, p. 261–265). This method was adopted and somewhat improved by *Maxwell*, 1875, in the Article Aether, Ency. Brit. 9th ed. Some further improvements have been introduced by the present writer, especially in those constants of the kinetic theory of the aether, which were never calculated by *Kelvin* or *Maxwell*. These are due entirely to the recent investigations, and are here outlined for the first time.

We adopt the constant of solar radiation recently found by *Bigelow*, namely, 3.98 ca., 1919. (Supplement No. I to the Treatises on the atmospheres of the sun and the earth. Four fundamental formulas for discussing the observations made with various types of pyrheliometers, *F. H. Bigelow*, John Wiley & Sons Inc., New York, 1919, p. 4).

A certain factor in the kinetic theory of the energy of the aether waves coming from the sun was taken by Lord *Kelvin* as between $1/2$ and 1, (Baltimore Lectures, p. 263, § 5), and by *Maxwell* as $1/2$. Working out the problem somewhat more fully than Lord *Kelvin* has done, thus taking account of the inclinations of all the wave elements in plane, circularly and elliptically polarized light, I find that this factor for the total energy should be a little greater than one half, namely:

$$\mathcal{J} = 1/(1/2\pi)\cdot\int_0^{1/2\pi}\cos\theta\,d\theta = 2/\pi = 0.63662.$$

Accordingly we thus arrive at the following

Table of Constants of the Aether:

1. Constant of solar radiation, found by *Bigelow* from observations, $R = 3.98$ ca.
2. Assumed ratio of amplitude to wave length $A/\lambda = 1/101.23$, which is nearly the same as was used by *Maxwell*, so that $Ap = 2\pi/101.23 = 1/16.115$.
3. Energy per cubic centimetre at the sun's surface $= (0.63662)\,\varrho\,V^2\,(Ap)^2 = 4.41455$ ergs.
4. Greatest tangential stress per sq. cm at the sun's surface $= \varrho\,V^2\,(Ap) = 111.1713$ dynes.
5. Coefficient of rigidity of the aether:
   at the sun's surface $= \varrho\,V^2 = 1800$,
   at the earth's surface $219\,\varrho\,V^2 = 394200$.
6. Density of the aether at the sun's surface $\varrho = 2\times10^{-15}$.
7. Density of the aether at the earth's surface $\varrho' = 219\,\varrho = 438\times10^{-18}$.
8. Mean velocity of the aetheron, $v' = 47\,123\,900\,000$ cms.
9. Molecular weight of the aetheron, $(H = 1)$ $= 15.56\times10^{-12}$.
10. Average length of mean free path, at the sun's surface, $l = 572959$ kms.
11. Number of corpuscular collisions per second, at the sun's surface, $C = 0.82246$.
12. Radius of aether corpuscle $= 3.346\times10^{-12}$, or $1/4005$ of the radius of a Hydrogen molecule.

The radius of a molecule of Hydrogen is taken as 1.34×10^{-8}, and the density assumed equal. In computing the molecular weight of the aetheron in 9 above, we disregard the so-called ‚Electrical mass' because Professor Sir *J. J. Thomson*, (Electricity and Magnetism, 4th ed., 1909, p. 521), and *Crowther*, (Molecular Physics, 1914, p. 70), and other authorities, admit that this ‚Electrical mass' resides in the aethereal medium itself, which we are investigating. This subject will be more fully discussed in a future paper.

It may be noticed that the aether gas, is endowed with enormously high molecular velocities and excessively long range of mean free path, so that the highly elastic aether is very different from the ordinary terrestrial gases. This is forcibly brought out in the following table; yet the similarity with the other gases is also notable, even for such an extreme case as the aether. It is this enormous mean molecular velocity and the long free path which causes the aether to vibrate as an elastic solid for rapidly acting forces, but easily gives way to slow motions. It is worthy of notice that the particles of the aether move out of the way ten thousand times more rapidly than the swiftest planets revolve in their orbits.

The constants for the tables assembled below were drawn originally from *O. E. Meyer*'s Kinetic Theory of Gases, but in the final revision I have adopted the mean of the values cited by *Jeans*, Kinetic Theory of Gases, 2nd ed. 1916.

Table for Comparing the Physical Properties of the Aether with well known Terrestrial Gases.

Gas	Mean velocity of molecule $\bar{v}$	Molecular wt. ($H = 1$)	Coefficient of viscosity $\varkappa$ at 0° C.	Mean free path $l = 3\varkappa/\rho\bar{v}$	Collisions per second $c = \bar{v}/l$ — 8 percent, for collision rebound	Radii of molecules calculated by four independent processes, except in the case of the aether
Aether	47 123 900 000 cms	15.56×10^{-12}	1800	57 295 900 000 cms = 572 959 kms	0.82	2.537×10^{-12} (= 1/4005 of H)
Air	49800 »	14.43	0.0001724	0.0000059 cms	7765×10^{6}	1.86×10^{-8}
Hydrogen	185 900 »	1	0.0000867	0.0000116 »	14743×10^{6}	1.34×10^{-8}
Helium	132 113 »	1.98	0.0001889	0.0000171 »	7108×10^{6}	1.11×10^{-8}
Oxygen	46 100 »	16	0.0001896	0.0000063 »	6732×10^{6}	1.81×10^{-8}
Nitrogen	49 200 »	14	0.0001660	0.0000057 »	7941×10^{6}	1.90×10^{-8}
Argon	41 527 »	19.96	0.000210	0.0000063 »	6064×10^{6}	1.81×10^{-8}
CO	49 700 »	14	0.0001626	0.0000058 »	7901×10^{6}	1.88×10^{-8}
CO_2	39 600 »	22	0.0001410	0.0000040 »	9108×10^{6}	2.28×10^{-8}
Chlorine	31 262 »	35.36	0.0001287	0.0000029 »	9874×10^{6}	2.68×10^{-8}
Steam H_2O	62 000 »	9	0.0000912	0.0000040 »	14260×10^{6}	2.27×10^{-8}

As was first clearly shown by *Maxwell*, viscosity is due to the molecular resistance developed when one layer of gas slides over another. In the case of such a superfine gas as the aether the viscosity passes into rigidity; the processes for establishing this transition of viscosity into rigidity is explained in *Daniell*'s Principles of Physics, 3rd ed., 1895, p. 227, and the theoretical basis of *Maxwell*'s theory of viscosity is notably improved by *Jeans*, Dynamical Theory of Gases, 2nd ed., 1916.

As the aether is a gas made up of corpuscles 4000 times smaller in diameter than a hydrogen molecule, and having only 15.56 millionths of a millionth of the mass of the hydrogen molecule, we readily see why this superfine medium pervades all gross bodies. But as the aether is the ultimate medium of the universe, and is not underlaid by anything finer, we also perceive that energy carried in such a medium cannot be dissipated, because there is no finer medium to which wave energy might be given up. Thus it follows that *Larmor*'s argument (in the article Aether, Encyc. Brit. 11th ed., 1911), to the effect that aether is not molecular, is not well founded. There is no valid objection to a corpuscular aether, such as was conceived by *Newton*, 1721, and approved by *Preston* and *Maxwell*, 1877. The kinetic theory of this superfine gas is here worked out in somewhat greater detail, and we see that quite unexpectedly it affords the most substantial physical ground ever developed for the most fundamental of all physical doctrines, namely, the conservation of energy.

Somewhat more detailed explanation of the processes of calculation used to derive the high molecular velocity of the aetheron are given in section 6 below. At present we need only point out the obvious advantages of having before our minds definite numerical results which show what manner of gas the aether is.

6. The excessively high molecular velocity of the aetheron, its long free path, and small mass, with radius only one four-thousandth of that of a Hydrogen molecule, ensures both great elasticity and great power of penetration to the aether.

The extraordinary elastic properties of the aether are due mainly to the excessively high velocity of the aetheron, its long free path, and small mass, with a radius of only one four-thousandth of that of a Hydrogen molecule. As far back as 1845, *Stokes* recognized (Trans. Camb. Phil. Soc., 8.287), that the aether is similar to well known solids, but has their physical properties in an accentuated degree. Thus ice, treacle, pitch, beeswax, molasses pulled for candy, and other substances are fluid for slowly acting forces, allowing hard bodies pressed into them to pass through without any fracture, by a gentle yielding or flow of the substance; but yet when struck violent blows these bodies vibrate like elastic solids, and may be fractured like glass or other brittle substances.

It thus appears that a solid is one which does not yield readily to the forces applied to it, and the resistance to change of shape with time measures the rigidity. All bodies, however, yield to forces in some degree. Now in the case of the aether the corpuscles have the enormous velocity of 471239 kilometres per second, as already pointed out: and in comparison with such tremendous speed, all earthly velocities are trivial. Even the velocities of our swiftest planets, like Mercury and Venus, are exceeded 10000-fold by the extreme swiftness of the aetherons. In addition to their rapid motion, they have the immensely long free path of 573000 kms, nearly one and a half times the moon's distance.

The enormous velocity of the aetheron and the great length of the mean free path makes the aether unique among all physical bodies. For rapidly acting forces it vibrates and transmits waves with a velocity of 300000 kms per second, and is capable of exerting the most tremendous stresses, such as are required for holding the planets in their orbits; but for slowly acting forces yields without resistance, because its own molecular motions are so rapid. The particles, travelling with such extreme velocity, get out of the way of all moving bodies — absolutely without hindrance, when the bodies move uniformly; and offer but slight resistance for changing velocity of movement due to acceleration or retardation.

It is recognized that the viscosity of gases, as determined by the diffusion experiments of *Loschmidt*, *O. E. Meyer*, *Maxwell* and others, depends on the molecular friction of the moving molecules projected from one layer of gas into another adjacent layer, when two layers are slid relatively

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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: $$l = 3\varkappa/\varrho\bar{v} \qquad (20)$$ 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: $N = 19\times10^{18}$ (*Maxwell*), $N = 1000\times10^{18}$ (*Crookes*), $N = 6000\times10^{18}$ (*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*, $N = 19\times10^{18}$, 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: $$\tfrac{1}{2} m_1 \bar{v}_1^{\,2} = \tfrac{1}{2} m_2 \bar{v}_2^{\,2} \qquad (21)$$ which gives

$$m_2 = m_1 (1859\ ^*))^2/(471239000)^2 = 15.56232\times10^{-12}. \qquad (22)$$

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

$$r = 1/4005.36 \cdot H \qquad (23)$$

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

$$r = 1.34\times10^{-8}/4000 = 3.346\times10^{-12}, \text{ nearly.} \qquad (24)$$

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:

$$V = M/r =$$

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

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«.

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

in the state of darkness, relative to the invisible aethereal medium, existing at the close of the 18th century, *Laplace* doubtless considered it sufficient to deal with expressions which give the forces acting on the planets, without inquiring into the geometrical nature and physical mechanism involved in the generation of these forces, which were then believed to lie beyond the reach of the investigator.

After the development of *Faraday*'s Experimental Researches in Electricity, and *Maxwell*'s mathematical interpretation of these results, very different views came to be entertained by geometers and natural philosophers. Yet it was only the developments brought out in the »Electrod. Wave-Theory of Phys. Forc.«, which seemed to justify definite expectations of forming clear geometrical and physical conceptions of the mechanism involved in the action of the magnetic and the planetary forces across space. Recently these conceptions have been verified and extended, and therefore we shall here attempt to give a geometrical and physical interpretation of the potential which so long proved bewildering to the physical mathematician.

In the »Electrod. Wave-Theory of Phys. Forc.«, 1917, p. 134, it is pointed out that if waves be the basis of physical action across space, then the amplitude of such waves when propagated spherically and without resistance, in tridimensional space, will be given by the equation:

$$A = k/r\,. \qquad (26)$$

In an address to the Academy of Sciences of St. Louis, Sept. 21, 1917, I gave this simple formula and pointed out its geometrical and physical significance. Professors *F. E. Nipher*, *E. A. Engler* and other physicists were present and showed great interest in the results announced, from which it would appear that this law had largely or entirely escaped the notice of earlier investigators.

Now by comparing this expression (26) with that in (25) above, we notice that the wave amplitude has the same form as the potential defined by *Laplace* in 1782. The question thus arises: Can the coincidence in form be due to chance, or is the potential in fact an analytical expression for the total aether stress due to the superposition of waves from all the atoms, each of the waves being of the average wave amplitude, appropriate to the coordinates in the field of force about an attracting mass? To get at the truth in this interesting inquiry, we notice that *Laplace*'s formula of 1782 integrates the mass of every particle of the attracting body, divided by its distance, which corresponds to a summation of the effects due to the superposed wave amplitudes and thus increases directly as the mass, each set of waves superposed from the atoms in any element $\sigma\,dx\,dy\,dz/r$, being independent of all the rest, but the triple integral including the accumulated wave action of the whole mass:

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

The elements under the integral signs represent the individual potentials of every particle, and thus the potential increases directly as the mass whose wave-effects are integrated. This conforms rigorously to our conceptions of the *Newton*ian law of attraction, and involves no approximation, since the element of mass $dm = \sigma\,dx\,dy\,dz$ can be made so small as to apply to every single particle or atom.

At first sight the mere fact that the potential V as thus defined follows the law of wave amplitude in tridimensional space strikingly suggests that the wave-theory represents the order of nature. To find out by exact calculation what is the probability of such a coincidence occurring by mere chance, we may proceed as follows.

Taking the expressions for two independent curves, the amplitude and the potential, we have:

$$A = y = k/x, \quad V = y = M/x\,. \qquad (27)$$

It will be noticed that they belong to the same geometrical species — both being rectangular hyperbolas referred to their asymptotes — and can be made identical throughout, from $x = 0$ to $x = \infty$, by introducing a summation Σ, such that $\Sigma k = M$.

Accordingly it appears that by the mere variation of a parameter the curves are made to coincide rigorously, point by point, from $x = 0$ to $x = \infty$. Therefore the chances against such a rigorous coincidence accidentally occurring throughout infinite space, $x = 0$ to $x = \infty$, becomes infinity to one, or,

$$C = \int_0^\infty dx = \infty \qquad (28)$$

and thus its actual occurrence points unmistakably to a true law of nature.

It seems therefore certain and incontestible that the potential represents geometrically and physically the total accumulated stress due to the whole mass under the average wave amplitude of the field about the attracting body in question.

It is to be noticed also that physically our definition of the potential confirms this conclusion. In free space there is no cause to alter the spherical distribution of the waves, as they expand with increase of r. But in or near the shadows of the earth, as shown in the »Electrod. Wave-Theory of Phys. Forc.«, a circular refraction of the sun's waves will necessarily occur. The sun's potential varies, even at a constant distance, near the shadow of the earth; and owing to this refraction, fluctuations of the moon's motion should arise near the time of lunar eclipses, as fully explained in this work of 1917. This circular refraction of the electrodynamic waves in passing through the earth's mass changes the potential or total accumulated stress due to the integration of the waves from all the atoms, under the average wave amplitude and distribution of the waves in the space near the shadow of the earth: and therefore also the sun's forces acting on the moon.

Partially released from the sun's control, by the interposition of the body of the earth, with its refractions of the sun's wave-field, the moon tends to fly the tangent while traversing the region of the shadow cone, and thus arise the fluctuations of the moon's mean motion, connected with lunar eclipses, which long perplexed *Laplace*, *Hansen*, *Newcomb*, *Hill*, *Brown* and other astronomers.

8. Explanation of the Propagation of the Wireless Waves around the Earth.

In the unpublished manuscript sent by the writer to the Royal Society in November, 1914, which was the first

outline of the »Electrod. Wave-Theory of Phys. Forc.« the following figure was used to illustrate the propagation of wireless waves around the earth.

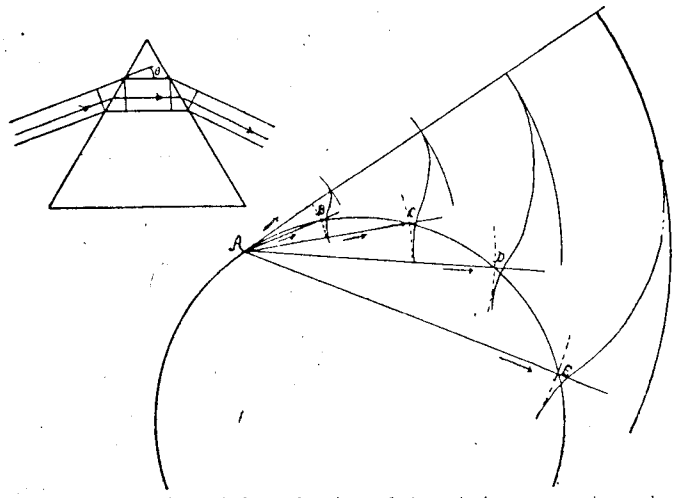

Fig. 2. Illustration of the refraction of the wireless wave about the earth, and of light in a prism, owing to slower propagation of waves in dense masses.

It is a sufficient explanation of this figure to say that it corresponds exactly with the propagation of light through a glass prism, as shown in the figure of the prism above. The wireless waves travel faster in air than through the solid earth. The enormous elasticity of the aether, as set forth in section 4, prevents bodily rupture of the medium; and this secures continuity of the wave front, by bending the surface backward near the globe, to correspond to the slower propagation in that dense mass. The retardation of the waves propagated straight through the earth causes the wave front to be bent and held back near the curved surface of the earth, and thus the wireless wave is refracted around the earth by the much greater resistance encountered in that solid mass.

The correct theory of the bending of the wireless wave about the globe is thus the same as that of a ray of light by a prism, as shown in the accompanying figure. The speed in the air is 4, but in the glass only 3, and thus there is a bending of the wave front through the angle θ when the light enters the glass, and also when it leaves the glass, as long recognized by physical investigators.

The explanation of the refraction of light in a prism is directly confirmed by *Foucault*'s celebrated experiment on the relative velocity of light in air and in water, (Annales de Chim. et de Phys. Sér. 3, t. 41, 1854), which has always been recognized as a crucial test of the wave theory of light, and which finally led to the total rejection of the emission theory.

The simplicity of the above explanation of the propagation of wireless waves about the globe is thus remarkable. But it is also confirmed experimentally by observations made by officers of the American Navy, upon wireless waves sent from Mare Island to San Diego, California, and received by submarines lying on the bed of the sea, through a depth of some 30 metres of sea water. In some experiments with the receiving apparatus underground the same effect was observed. It appears that the earth also conducts the signals, so that wireless apparatus may be installed and used in deep mines, which would enormously increase the power of signalling in case of accidents interrupting communication by the shafts and tunnels.

It is probable, however, that the irregularity in the structure and conducting power of the earth's strata would somewhat handicap such underground signalling, yet not prevent the successful development of the method of signalling through the earth to the limited depths at which miners work.

The problem of explaining the propagation of wireless waves about the earth has hitherto challenged the ingenuity of the foremost mathematicians. It has been unsuccessfully attacked by Professor *H. M. Macdonald* (Proc. Roy. Soc. 1903 and Phil. Trans. 1910), Lord *Rayleigh* and Prof. *H. Poincaré* (Proc. Roy. Soc. 1903). See also *Poincaré*'s Lectures of 1908 (La Lumière Électrique, vol. 4, 2nd series, Nov. 28, Dec. 5, 12, 19, 1908, especially p. 323). Professor *A. Sommerfeld* (Ann. der Phys., vol. 28, p. 665, 1909) has shown that a surface wave should exist; and Professor *J. W. Nicholson* (in the Phil. Mag., March, April, May, 1910) has dealt with certain problems of the exponential factor of the wave amplitude, but none of these eminent mathematicians arrived at any satisfactory theory of wave propagation about the globe.

In his well known work on the Principles of Electric Wave Telegraphy and Telephony, London, 3rd edition, 1916, p. 826–851, Professor *J. A. Fleming* gives a full and accurate account of the difficulty experienced by these and other mathematicians. In this revised edition of 1916, *Fleming* gives the following: »General conclusions as to the mode of propagation of long electric waves round the earth«.

»Summing up the conclusions so far reached by radio-telegraphists we may say that the effect produced by a radio-telegraphic transmitter at a great distance, say 2000 or 6000 miles over the surface of the earth, is 'a complex one in which several different actions play a part«.

»There is, first, a propagation through the aether of a true space electromagnetic wave which is diffracted round the earth. The extent to which this contributes to the whole effect is, perhaps, greater than was formerly supposed, but is yet an undetermined quantity. Some mathematicians are now inclined to attribute to it the major portion of the transmission by day«.

»Then in the next place there is undoubtedly a contribution made to the effect by waves which have suffered a refraction equivalent to a reflection by ionized air at high altitudes, and a very small effect due to the decrease in refractive index of air as we ascend upwards«.

»These causes tend to make the ray follow round the curvature of the earth and so assist as it were diffraction. It is to this variable ionic refraction that we must attribute the diurnal and annual variations in signal strength, and also the greater signalling distance by night as well as the irregularities attending the transition times of sunrise and sunset«.

»Then in addition we may inquire how far any contribution is made by a surface wave of the type investigated by *Sommerfeld*, which is equivalent to an electric wave propagated through or along the earth«.

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»It has been definitely proved that we can receive signals from stations hundreds of miles away without any high receiving aerial, but merely by connecting one terminal of the receiving circuit to earth, and the other terminal to any large well-insulated mass of metal, whether inside or outside of a house does not matter«.

If I understand the difficulties so lucidly outlined by *Fleming*, they will be found to have proceeded from the inadequate theory of the aether heretofore in use, the discussion being based upon diffraction around the earth, instead of upon refraction and dispersion within the denser mass of the earth, and thus a bending of the wave front. This will sufficiently justify this quotation, since it is essential that the difficulties heretofore encountered should be authoritatively described. The reader can then judge as to whether a simpler and more practicable solution of this problem has been obtained.

As to the feebleness of wireless transmission by day, I have reached the settled conviction that it results from the magnetic wave field of the sun. When this storm of waves fills our air by day, the wireless waves have great difficulty in getting through, — just as any system of regular water waves in a lake, used for signalling across it, would be almost lost in distinctness, owing to the surface churning of the lake under the violence of a wind storm. The transmission is more difficult with the distance, and, after a certain distance, entirely fails. At night the sun's magnetic wave field is largely absent, and thus wireless transmission is much better.

It only remains to add that the celebrated argument of *Cauchy*, to the effect that refractive dispersion of light necessarily implies a granular structure in the transparent matter, is equally valid for showing that the aethereal medium itself is corpuscular. In his Popular Lectures and Addresses 1.190, Lord *Kelvin* has modified *Cauchy*'s theory of refractive dispersion in his usual lucid manner. It is believed that the considerations adduced in this paper will render the arguments of both *Cauchy* and *Kelvin* somewhat more definite and interesting.

When the aetheron is so small, and moving so rapidly, the generation and propagation of waves in the aether is intelligible. The refractive dispersion, by the resistance to the waves from the much larger molecules of ordinary matter; is easily understood; and thus refractive dispersion implies in common matter, coarser granules than those of the medium itself, but yet points to the moving aetherons as easily deranged by the resistance of the waves dispersed.

It will be shown hereafter that resistance soon changes the form of the wave, and causes it to break up into two distinct parts, the larger having increased amplitude, and shorter length, hence encountering more resistance than the original wave. It is certain therefore that we not only have retardation in the propagation through the earth, but also dispersion of the fragmentary waves, and absorption of some of their energy as heat.

9. Outlines of the Wave-Theory of Magnetism, with explanation of the mechanism of Attraction and Repulsion.

For the sake of completeness the present investigation requires a brief notice of the cause of attraction and repulsion in magnets, and in electrodynamic action, as first outlined in the vol. 1, Electrod. Wave-Theory of Phys. Forc., 1917. Accordingly we begin with magnetism, which the celebrated English physicist *Maxwell* had been so long engaged upon, but had failed to solve at the time of his death 40 years ago.

The accompanying figure from the work of 1917 will illustrate to the eye the essential character of a magnet, as conceived in the wave-theory of physical forces. A large magnet *A* is exhibited in the same field with two smaller magnets, *B*. In the first case unlike poles are presented, and we have mutual attraction. In the second case the poles presented are like, with the well known result of mutual repulsion. But how does this attraction and repulsion come about? What mechanism is involved, and in what medium does it work? Obviously the medium is the aether, because an electric current produces a magnet from a piece of steel wound in a solenoid, and because also the electrodynamic action of a current travels with the velocity of light, as was first inferred by *Maxwell*, and afterwards proved by experiment.

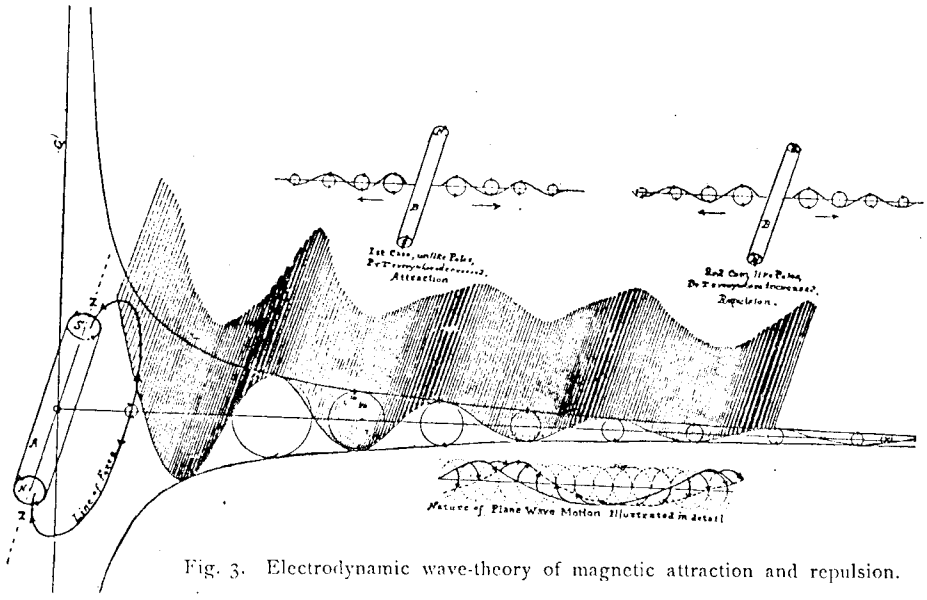

Fig. 3. Electrodynamic wave-theory of magnetic attraction and repulsion.

A) In the case of attraction, it will be seen that the waves from the small magnet *B* have the elements of the aether rotating in the opposite direction to the rotations in the more fully outlined waves from the magnet *A*. The plane waves from *A* are to be imagined, for the sake of simplicity, in the central plane, or equator, and travelling away with the velocity of light, — for the reason just assigned in electrodynamic action, by which magnets are produced.

As shown graphically by the curve traced just above the heavy waves in the figure, the amplitude of these receding waves decreases according to the law:

$$A = k/r \qquad (29)$$

and as the force due to wave action is shown, in works on physics, to be proportional to the square of the amplitude, we have for the force:

$$f = k^2/r^2 \qquad (30)$$

which is the form of law for gravitation, magnetism, and all similar forces of nature obeying the law of the inverse squares.

Now let the waves from magnet *B* interpenetrate the waves from magnet *A*. It will be seen that at every point of space the rotations of the elements of the two sets of waves are exactly opposite: the result is that the rotations from magnet *B* undo as far as possible the opposite rotations from magnet *A*. Accordingly the stresses in the medium due to rotations of the aether, in the field between *A* and *B*, and also beyond *A* and *B*, are reduced: the medium is thus everywhere less agitated than before, and shrinks, so as to collapse or contract between *A* and *B*. But a collapse of the aether is equivalent to a contraction, and thus the two bodies attract as if held together by a stretched mass of india rubber. This is a simple and direct explanation of attraction. Nothing is postulated except waves like those known to exist in light and heat, but here seen to be exactly parallel and somewhat differently directed from those of light and heat, which usually have their planes tilted in haphazard fashion.

B) The cause of repulsion is similar to that of attraction, but in this case the poles presented are like; and if we examine the above diagram, we discover that when the waves from magnet *B*, 2nd case, interpenetrate the waves from magnet *A*, the rotations at every point will be conformable and in the same direction. The medium therefore at every point is more agitated than before. The amplitudes of the disturbed waves are thereby increased, and hence there is an increase of stress; and under the elasticity of the aether the result is an expansion of the medium, which gives a mutual repulsion of the two bodies.

This is a simple explanation of repulsion, and it had never been worked out prior to the researches published by the writer in 1917. *Maxwell* was unable to conceive of any mechanism for the explanation of attraction and repulsion of magnets, though he found that mathematical stresses of a certain type, yielding tension along the lines of force and pressure at right angles thereto, thus dynamically equivalent to those outlined above, would account for the phenomena of magnetism.

It is true that *Maxwell* believed that there are rotations around the *Faraday* lines of force, as Lord *Kelvin* had also rendered probable as early as 1856; but neither *Kelvin* nor *Maxwell* had seen that this would arise from the type of waves here outlined, though *Faraday*'s experiment of 1845, on the rotation of the plane of a beam of polarized light, — when passed along the line of force, through a dense medium such as lead glass, — should have suggested the correct theory of the magnetic waves to *Kelvin* and *Maxwell*, as it did to me in 1916.

As *Maxwell* was unable to unlock the secret of magnetism, with both attraction and repulsion, it will not greatly surprise us to learn that he was utterly bewildered by the mystery of gravitation, and could not make a successful attack upon this most difficult problem.

In fact no considerable progress as to the cause of gravitation has been made by other investigators since the time of *Newton*. As the subject of gravitation is immense, we must not enter upon it here, except to say that the evidence is most conclusive that it is a wave-phenomenon, closely allied to that of magnetism, but differing from magnetism which has a parallel arrangement of the atoms and what *Airy* calls (Treatise on Magnetism, 1870, p. 10) a duality of powers — two poles — while gravitation is a central action only, owing to the haphazard arrangement of the planes of the atoms.

It is well known that about 1822 *Ampère* first made electro-magnets out of common steel, by means of an electric current sent through a solenoid. The way in which the wire is wound about the bar being magnetized suggests, and, in fact, proves that the wire bearing the current has a wave-field about it. There is proof that the waves are flat in the planes through the axis of the wire: this conception harmonizes all the known phenomena of magnetism, in relation to electrodynamic action, and also harmonizes *Ampère*'s theory of elementary electric currents about the atoms with the wave-theory of magnetism above set forth.

The wave-theory of magnetism explains all the phenomena of terrestrial magnetism, in relation to the periodic influences of the sun and moon, such as magnetic storms, earth currents, the aurora, and the semi-diurnal magnetic tide depending on the moon, of which no other explanation is known. For the dependence of magnetic storms on sunspots consult a paper by the author, in the Bulletin Société Astr. de France, November, 1918.

There has been such a bewildering confusion of thought connected with the whole subject of physical action across space that it is necessary to bear in mind clearly the fundamental principles of natural philosophy. In the well known article on attraction, (Scientific Papers, vol. 2.487), *Maxwell* points out that in the Optical Queries included in the third edition of the Optics, 1721, *Newton* shows that if the pressure of the aethereal medium is less in the neighborhood of dense bodies than at great distances from them dense bodies will be drawn towards each other, and if the diminution of pressure is inversely as the distance from the dense body, the law will be that of gravitation. *Maxwell* considers that *Newton*'s conception rests largely on the idea of hydrostatic pressure, as in incompressible liquids. But we have shown that the amplitude of the waves, $A = k/r$, with forces $f = k^2/r^2$, fulfills the condition which *Newton* held to be essential.

10. Integration of the General Differential Equations of an Elastic Solid, which applies to the Aether, when this Medium is viewed as an Infinite Aeolotropic Elastic Solid propagating Waves.

As is usual in the theory of an elastic solid, let m denote a function of the bulk modulus k, and of the rigidity n, such that

$$m = k + {}^1/_3 n. \qquad (31)$$

Then $k = m - {}^1/_3 n$, and this bulk modulus measures the elastic force called out by, or the elastic resistance against, change of volume. On the other hand the »compressibility« is measured by

$$1/k = 1/(m - {}^1/_3 n). \qquad (32)$$

Let α, β, γ be the component displacements experienced by a particle, so that when undisturbed the coordinates are x, y, z, and when disturbed $x+\alpha, y+\beta, z+\gamma$. Then a strain of any magnitude is specified by six elements:

$$\begin{aligned} A &= \left(\frac{\partial\alpha}{\partial x}+1\right)^2+\left(\frac{\partial\beta}{\partial x}\right)^2+\left(\frac{\partial\gamma}{\partial x}\right)^2 & a &= \frac{\partial\alpha}{\partial y}\frac{\partial\alpha}{\partial z}+\left(\frac{\partial\beta}{\partial y}+1\right)\frac{\partial\beta}{\partial z}+\frac{\partial\gamma}{\partial y}\left(\frac{\partial\gamma}{\partial z}+1\right) \\ B &= \left(\frac{\partial\alpha}{\partial y}\right)^2+\left(\frac{\partial\beta}{\partial y}+1\right)^2+\left(\frac{\partial\gamma}{\partial y}\right)^2 & b &= \frac{\partial\alpha}{\partial z}\left(\frac{\partial\alpha}{\partial x}+1\right)+\frac{\partial\beta}{\partial z}\frac{\partial\beta}{\partial x}+\left(\frac{\partial\gamma}{\partial z}+1\right)\frac{\partial\gamma}{\partial x} \\ C &= \left(\frac{\partial\alpha}{\partial z}\right)^2+\left(\frac{\partial\beta}{\partial z}\right)^2+\left(\frac{\partial\gamma}{\partial z}+1\right)^2 & c &= \left(\frac{\partial\alpha}{\partial x}+1\right)\frac{\partial\alpha}{\partial y}+\frac{\partial\beta}{\partial x}\left(\frac{\partial\beta}{\partial y}+1\right)+\frac{\partial\gamma}{\partial x}\frac{\partial\gamma}{\partial y}. \end{aligned} \tag{33}$$

All particles in an unstrained state, which lie on a spherical surface:

$$r_1^2 = \xi_1^2+\eta_1^2+\zeta_1^2 \tag{34}$$

will, in a strained state, lie on an ellipsoidal surface:

$$A\xi^2+B\eta^2+C\zeta^2+2a\eta\zeta+2b\zeta\xi+2c\xi\eta = r_1^2. \tag{35}$$

Accordingly, if the external forces at $P(x\,y\,z)$ along the axes of x, y, z, be X, Y, Z, per unit of mass, and the internal stresses be:

$$\begin{aligned} \left(\frac{\mathrm{d}\mathfrak{p}_{xx}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yx}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zx}}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}P}{\mathrm{d}x}+\frac{\mathrm{d}U}{\mathrm{d}y}+\frac{\mathrm{d}T}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z \\ \left(\frac{\mathrm{d}\mathfrak{p}_{xy}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yy}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zy}}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}U}{\mathrm{d}x}+\frac{\mathrm{d}Q}{\mathrm{d}y}+\frac{\mathrm{d}S}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z \\ \left(\frac{\mathrm{d}\mathfrak{p}_{xz}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yz}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zz}}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}T}{\mathrm{d}x}+\frac{\mathrm{d}S}{\mathrm{d}y}+\frac{\mathrm{d}R}{\mathrm{d}z}\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z. \end{aligned} \tag{36}$$

Then the equilibrium of all the forces, internal and external, leads to the following equation:

$$\begin{aligned} \left(\frac{\mathrm{d}\mathfrak{p}_{xx}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yx}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zx}}{\mathrm{d}z}+\varrho X\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}P}{\mathrm{d}x}+\frac{\mathrm{d}U}{\mathrm{d}y}+\frac{\mathrm{d}T}{\mathrm{d}z}+\varrho X\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z = 0 \\ \left(\frac{\mathrm{d}\mathfrak{p}_{xy}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yy}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zy}}{\mathrm{d}z}+\varrho Y\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}U}{\mathrm{d}x}+\frac{\mathrm{d}Q}{\mathrm{d}y}+\frac{\mathrm{d}S}{\mathrm{d}z}+\varrho Y\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z = 0 \\ \left(\frac{\mathrm{d}\mathfrak{p}_{xz}}{\mathrm{d}x}+\frac{\mathrm{d}\mathfrak{p}_{yz}}{\mathrm{d}y}+\frac{\mathrm{d}\mathfrak{p}_{zz}}{\mathrm{d}z}+\varrho Z\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z &= \left(\frac{\mathrm{d}T}{\mathrm{d}x}+\frac{\mathrm{d}S}{\mathrm{d}y}+\frac{\mathrm{d}R}{\mathrm{d}z}+\varrho Z\right)\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z = 0. \end{aligned} \tag{37}$$

These are the general equations of equilibrium of an elastic solid, when subjected to strain by any system of forces, internal and external.

For an isotropic solid, the equations become much simplified. Using $m = k+\frac{1}{3}n$, as in (31), we find the well known formulae for an elastic solid, of density ϱ per unit volume, (cf. *Thomson* and *Tait*, Treatise on Natural Philosophy, edition 1883, § 698)

$$\begin{aligned} m\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\partial\alpha}{\partial x}+\frac{\partial\beta}{\partial y}+\frac{\partial\gamma}{\partial z}\right)+n\left(\frac{\partial^2\alpha}{\partial x^2}+\frac{\partial^2\alpha}{\partial y^2}+\frac{\partial^2\alpha}{\partial z^2}\right)+\varrho X = 0 \\ m\frac{\mathrm{d}}{\mathrm{d}y}\left(\frac{\partial\alpha}{\partial x}+\frac{\partial\beta}{\partial y}+\frac{\partial\gamma}{\partial z}\right)+n\left(\frac{\partial^2\beta}{\partial x^2}+\frac{\partial^2\beta}{\partial y^2}+\frac{\partial^2\beta}{\partial z^2}\right)+\varrho Y = 0 \\ m\frac{\mathrm{d}}{\mathrm{d}z}\left(\frac{\partial\alpha}{\partial x}+\frac{\partial\beta}{\partial y}+\frac{\partial\gamma}{\partial z}\right)+n\left(\frac{\partial^2\gamma}{\partial x^2}+\frac{\partial^2\gamma}{\partial y^2}+\frac{\partial^2\gamma}{\partial z^2}\right)+\varrho Z = 0. \end{aligned} \tag{38}$$

When an elastic substance is strained, as in the propagation of waves, its different elements undergo changes both of form and of volume.

Let $$\delta = \partial\alpha/\partial x+\partial\beta/\partial y+\partial\gamma/\partial z \tag{39}$$

denote the amount of dilatation in volume experienced by an element of the substance and put

$$\nabla^2 = \mathrm{d}^2/\mathrm{d}x^2+\mathrm{d}^2/\mathrm{d}y^2+\mathrm{d}^2/\mathrm{d}z^2 \tag{40}$$

for the Laplacian operation: then we shall be able to reduce these expressions (38) to the very simple form:

$$\begin{aligned} m\cdot\mathrm{d}\delta/\mathrm{d}x+n\nabla^2\alpha+\varrho X = 0 \\ m\cdot\mathrm{d}\delta/\mathrm{d}y+n\nabla^2\beta+\varrho Y = 0 \\ m\cdot\mathrm{d}\delta/\mathrm{d}z+n\nabla^2\gamma+\varrho Z = 0. \end{aligned} \tag{41}$$

Now when the solid is isotropic, the density may be omitted in these formulae, or taken as unity. Accordingly if we differentiate these successive equations with respect to x, y, z respectively, and add the results, we shall get the equation for an Isotropic Solid:

$$(m+n)\nabla^2\delta+(\mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z) = 0. \tag{42}$$

11. Identity of the Dilatation $\delta = \partial\alpha/\partial x+\partial\beta/\partial y+\partial\gamma/\partial z$ with the Potential V for an Infinite Elastic Solid: Confirmation of the Wave-Theory by Lord *Kelvin*'s Integrals of 1848.

It is remarkable that under certain conditions, to be more fully discussed hereafter, the equations of an infinite elastic solid admit of a very simple interpretation. This amounts to admitting the identity of the dilatation δ with the potential V, in the case of an infinite elastic solid. Indeed it was upon this tacit assumption, seventy two years ago, that Lord *Kelvin* obtained his celebrated integrals for

an infinite elastic solid (cf. Cambridge and Dublin Mathematical Journal, 1848).

It may be noted that the density of an isotropic solid, which does not vary with the coordinates (x, y, z), is expressed by the ratio,

$$\varrho = [(m+n)\,\nabla^2\delta]/(\mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z)\,. \qquad (43)$$

But by *Poisson*'s equation we have

$$\nabla^2 V+4\pi\varrho = 0 \qquad \varrho = -\nabla^2 V/4\pi \qquad (44)$$

or
$$\varrho = -(1/4\pi)\,(\partial^2 V/\partial x^2+\partial^2 V/\partial y^2+\partial^2 V/\partial z^2)\,. \qquad (45)$$

By comparing (43) and (45), we find that if a mass of density,

$$\varrho = 1/[4\pi\,(m+n)]\cdot\left(\frac{\mathrm{d}X}{\mathrm{d}x}+\frac{\mathrm{d}Y}{\mathrm{d}y}+\frac{\mathrm{d}Z}{\mathrm{d}z}\right) \qquad (46)$$

be distributed throughout space, we may conclude that its potential at (x, y, z) will be identical with the dilatation of the elastic solid substance:

$$\delta = \partial\alpha/\partial x+\partial\beta/\partial y+\partial\gamma/\partial z\,. \qquad (47)$$

For if we divide (42) by $(m+n)$, and subtract from it the first of (44), we get:

$$\nabla^2\delta+(\mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z)/(m+n)+ -\nabla^2 V-4\pi\varrho = 0 \qquad (48)$$

which gives
$$\nabla^2(\delta - V) = 0 \qquad (49)$$

if
$$\mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z-4\pi\varrho\,(m+n) = 0 \qquad (50)$$

or the density is defined by the expression:

$$\varrho = 1/[4\pi\,(m+n)]\cdot(\mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z)\,. \qquad (51)$$

This specifies the density throughout space of the infinite isotropic solid, that of the finite solid body in (41) being unity per unit of volume.

To reach Lord *Kelvin*'s result most directly, we let R denote the resultant of the forces, X, Y, Z, at any point (x, y, z), at the distance $r = \sqrt{(x^2+y^2+z^2)}$ from the origin, whether discontinuous and vanishing in all points outside some finite closed surface, or continuous and vanishing at all infinitely distant points with sufficient convergency to make Rr converge to 0 as r increases to ∞. Then the convergency of Xr, Yr, Zr to zero, when r is infinite, clearly makes $V = 0$ for all infinitely distant points. Accordingly, if S be any closed surface round the origin of coordinates, everywhere infinitely distant from it, the function $(\delta - V)$ is zero for all points of it, and satisfies the equation $\nabla^2(\delta - V) = 0$ for all points within it. Therefore $\delta = V$ throughout the infinite isotropic solid.

Now let X', Y', Z' denote the values of X, Y, Z at any point (x, y, z), and by a triple integration throughout all space, we shall have for the potential V or dilatation δ:

$$\delta = 1/[4\pi\,(m+n)]\cdot\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(\mathrm{d}X'/\mathrm{d}x'+\mathrm{d}Y'/\mathrm{d}y'+\mathrm{d}Z'/\mathrm{d}z')/\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}\cdot\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'. \qquad (52)$$

For the element of the mass is
$$\varrho = 1/[4\pi\,(m+n)]\cdot(\mathrm{d}X'/\mathrm{d}x'+\mathrm{d}Y'/\mathrm{d}y'+\mathrm{d}Z'/\mathrm{d}z') \qquad (53)$$

and the mutual distances of the elements of mass filling the element of space $\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$ is

$$r = \sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}\,. \qquad (54)$$

These expressions may be rendered more convenient by integrating by parts, and noticing the prescribed condition of convergence, according to which when x' is infinite,

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}X'/\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}\cdot\mathrm{d}y'\,\mathrm{d}z' = 0\,. \qquad (55)$$

And, therefore, for the three components of finite value, resolved along the coordinate axes, and integrated throughout all space, we have:

$$\delta = 1/[4\pi\,(m+n)]\cdot\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}[X'(x-x')+Y'(y-y')+Z'(z-z')]/\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}\cdot\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'. \qquad (56)$$

We may integrate each of the equations (38) in the same way, for α, β, γ respectively. The result for these displacements is:

$$\alpha = u+U \qquad \beta = v+V \qquad \gamma = w+W \qquad (57)$$

where u, v, w, U, V, W denote the potentials at (x, y, z) of distributions of matter through all space of densities respectively

$$(m/4\pi n)\,\partial\delta/\partial x \qquad (m/4\pi n)\,\partial\delta/\partial y \qquad (m/4\pi n)\,\partial\delta/\partial z \qquad X/4\pi n \qquad Y/4\pi n \qquad Z/4\pi n\,. \qquad (58)$$

In other words the functions are such that throughout all space

$$\nabla^2 u+(m/n)\,\partial\delta/\partial x = 0 \quad \nabla^2 U+X/n = 0 \qquad \nabla^2 v+(m/n)\,\partial\delta/\partial y = 0 \quad \nabla^2 V+Y/n = 0$$
$$\nabla^2 w+(m/n)\,\partial\delta/\partial z = 0 \quad \nabla^2 W+Z/n = 0\,. \qquad (59)$$

Accordingly, if X'', Y'', Z'' denote the values of X, Y, Z for a point (x'', y'', z''), we find

$$\alpha = (1/4\pi n)\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(m\cdot\partial\delta''/\partial x''+X'')/\sqrt{[(x-x'')^2+(y-y'')^2+(z-z'')^2]}\cdot\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z''$$
$$\beta = (1/4\pi n)\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(m\cdot\partial\delta''/\partial y''+Y'')/\sqrt{[(x-x'')^2+(y-y'')^2+(z-z'')^2]}\cdot\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z'' \qquad (60)$$
$$\gamma = (1/4\pi n)\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(m\cdot\partial\delta''/\partial z''+Z'')/\sqrt{[(x-x'')^2+(y-y'')^2+(z-z'')^2]}\cdot\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z''\,.$$

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By substituting for δ'' its value in (56), we obtain expressions for α, β, γ depending on the sums of a sextuple integral and a triple integral, the integrations having to be performed from $-\infty$ to $+\infty$:

$$\alpha = \frac{1}{4\pi n}\iiint\left\{m\frac{\mathrm{d}}{\mathrm{d}x}\left[\frac{-1}{4\pi(m+n)}\iiint\frac{X'(x''-x')+Y'(y''-y')+Z'(z''-z')}{[(x''-x')^2+(y''-y')^2+(z''-z')^2]^{3/2}}\,\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'+X''\right\}\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z''}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}}$$

$$\beta = \frac{1}{4\pi n}\iiint\left\{m\frac{\mathrm{d}}{\mathrm{d}y}\left[\frac{-1}{4\pi(m+n)}\iiint\frac{X'(x''-x')+Y'(y''-y')+Z'(z''-z')}{[(x''-x')^2+(y''-y')^2+(z''-z')^2]^{3/2}}\,\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'+Y''\right\}\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z''}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}} \qquad (61)$$

$$\gamma = \frac{1}{4\pi n}\iiint\left\{m\frac{\mathrm{d}}{\mathrm{d}z}\left[\frac{-1}{4\pi(m+n)}\iiint\frac{X'(x''-x')+Y'(y''-y')+Z'(z''-z')}{[(x''-x')^2+(y''-y')^2+(z''-z')^2]^{3/2}}\,\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'+Z''\right\}\mathrm{d}x''\,\mathrm{d}y''\,\mathrm{d}z''}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}}.$$

Lord *Kelvin* shows how to simplify these sextuple integrals, and obtains the following general solution for the displacements produced by any distribution of force through an infinite elastic solid filling all space (limits of integration as before $-\infty$ and $+\infty$):

$$\alpha = \frac{1}{2\cdot 4\pi n(m+n)}\iiint\left\{\frac{2(2m+3n)X'}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}} - m[(x-x')^2+(y-y')^2+(z-z')^2]\frac{\mathrm{d}}{\mathrm{d}x}\frac{X'(x-x')+Y'(y-y')+Z'(z-z')}{[(x-x')^2+(y-y')^2+(z-z')^2]^{3/2}}\right\}\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'$$

$$\beta = \frac{1}{2\cdot 4\pi n(m+n)}\iiint\left\{\frac{2(2m+3n)Y'}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}} - m[(x-x')^2+(y-y')^2+(z-z')^2]\frac{\mathrm{d}}{\mathrm{d}y}\frac{X'(x-x')+Y'(y-y')+Z'(z-z')}{[(x-x')^2+(y-y')^2+(z-z')^2]^{3/2}}\right\}\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z' \qquad (62)$$

$$\gamma = \frac{1}{2\cdot 4\pi n(m+n)}\iiint\left\{\frac{2(2m+3n)Z'}{\sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}} - m[(x-x')^2+(y-y')^2+(z-z')^2]\frac{\mathrm{d}}{\mathrm{d}z}\frac{X'(x-x')+Y'(y-y')+Z'(z-z')}{[(x-x')^2+(y-y')^2+(z-z')^2]^{3/2}}\right\}\mathrm{d}x'\,\mathrm{d}y'\,\mathrm{d}z'.$$

This whole investigation is based upon the integration of the general equations for an infinite isotropic elastic solid: which implies that the density throughout all space shall be equal to ϱ as defined by (46).

Lord *Kelvin*'s definition of X, Y, Z as any arbitrary functions whatever of (x, y, z), either discontinuous and vanishing at all points outside some finite closed surface, or continuous and vanishing at all infinitely distant points with sufficient convergency to make the product of their resultant $R = \sqrt{(X^2+Y^2+Z^2)}$, by the distance

$$r = \sqrt{[(x-x')^2+(y-y')^2+(z-z')^2]}$$

namely Rr, converge to zero as r approaches infinity, implies that the density may vary through changes in the differential elements $\qquad \mathrm{d}X/\mathrm{d}x+\mathrm{d}Y/\mathrm{d}y+\mathrm{d}Z/\mathrm{d}z = \nabla^2 V \qquad (63)$

as shown below.

But no other changes than those in $\nabla^2 V$, the Laplacian operation on the potential can occur; and even this is chiefly at the boundaries of solid bodies. Accordingly it becomes advisable to investigate these possible changes a little more closely.

12. Geometrical and Physical Conditions which the Forces generated must satisfy.

Suppose X, Y, Z to denote the components of the forces acting on an element of the solid $\mathrm{d}m = \varrho\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z$, temporarily imagined to be fluid at (x, y, z), reckoned per unit of the mass. Then the difference of the pressures on the two faces $\delta y\,\delta z$ of the rectangular parallelopiped of the fluid is

$$\delta y\,\delta z\,(\mathrm{d}\mathfrak{p}/\mathrm{d}x)\,\mathrm{d}x \qquad (64)$$

and this fluid element will be in equilibrium when the following equations are satisfied:

$$\begin{aligned}\delta y\,\delta z\,(\mathrm{d}\mathfrak{p}/\mathrm{d}x)\,\delta x - X\,\delta x\,\delta y\,\delta z &= 0\\ \delta z\,\delta x\,(\mathrm{d}\mathfrak{p}/\mathrm{d}y)\,\delta y - Y\,\delta x\,\delta y\,\delta z &= 0\\ \delta x\,\delta y\,(\mathrm{d}\mathfrak{p}/\mathrm{d}z)\,\delta z - Z\,\delta x\,\delta y\,\delta z &= 0;\end{aligned} \qquad (65)$$

which give the necessary and sufficient condition for the equilibrium of any fluid mass:

$$\mathrm{d}\mathfrak{p}/\mathrm{d}x = X \qquad \mathrm{d}\mathfrak{p}/\mathrm{d}y = Y \qquad \mathrm{d}\mathfrak{p}/\mathrm{d}z = Z. \qquad (66)$$

From these equations we obtain immediately

$$\begin{aligned}\mathrm{d}\mathfrak{p} &= \mathrm{d}\mathfrak{p}/\mathrm{d}x\cdot\mathrm{d}x+\mathrm{d}\mathfrak{p}/\mathrm{d}y\cdot\mathrm{d}y+\mathrm{d}\mathfrak{p}/\mathrm{d}z\cdot\mathrm{d}z\\ &= \varrho\,(X\,\mathrm{d}x+Y\,\mathrm{d}y+Z\,\mathrm{d}z).\end{aligned} \qquad (67)$$

This equation shows that $X\,\mathrm{d}x+Y\,\mathrm{d}y+Z\,\mathrm{d}z$ is the completed differential of a function $\mathfrak{p}(x, y, z)$ of three independent variables, or may be made so by a factor. Physically this is equivalent to concluding that the pressure in the fluid is along the lines of force, and thus a series of surfaces exists which cuts the lines of force at right angles. If the forces belong to a conservative system, say when a gravitational mass has attained a state of internal equilibrium, as in the theory of the figures of the heavenly bodies, no factor is required to render the differential complete, and we may put

$$X\,\mathrm{d}x+Y\,\mathrm{d}y+Z\,\mathrm{d}z = -\mathrm{d}V \qquad (68)$$

or by (67) $\qquad \mathrm{d}\mathfrak{p} = -\varrho\,\mathrm{d}V. \qquad (69)$

This expression shows that the pressure $\mathfrak{p}$ is constant over the equipotential surfaces,

$$\varrho = -\mathrm{d}\mathfrak{p}/\mathrm{d}V \qquad (70)$$

and the density also is a function of the potential V. This condition arises when the density of the body is uniform, over the equipotential surfaces, for the distribution of force

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to which the components (P, Q, R) belong — corresponding to a homogeneous elastic solid, or a mass of incompressible liquid held in a rigid vessel, with the density so distributed as to be in equilibrium. The second equation of (67) is satisfied by this condition, and we have,

$$dX/dx+dY/dy+dZ/dz = \nabla^2 W. \qquad (71)$$

Accordingly by (42) we have the original equation of an elastic solid: $$(m+n)\nabla^2\delta+\nabla^2 W = 0 \qquad (72)$$

which is satisfied by the assumption $\delta = -W/(m+n)$.

The Aether as an Infinite Elastic Solid.

Hence if this analysis applies to the aether, as an infinite elastic solid, the density of the medium must be arranged so as to give a potential augmenting about each mass of matter embedded in it, as shown in my Dynamical Theory of Globular Clusters, 1912. This latter condition of the potential is described analytically as follows:

$$\omega = \int\int\int \frac{\varrho\, dx\, dy\, dz}{V[(x-x')^2+(y-y')^2+(z-z')^2]} = \int \frac{dm}{r} \qquad (73)$$

and the inference, from Dynamical Theory, that the potential is greater towards the centres of matter, finds obvious physical illustration in the accumulated arrangement of globular clusters, with the starlight increasing in brightness till it attains a perfect blaze near the centre, in such splendid globular clusters as 47 Tucani and ω Centauri.

This increase in potential towards the centres occupied by matter can only be attributed to centripetal stresses in the aether: the medium is thus filled with waves receding from these masses, and the density in the agitated medium is inversely as the wave amplitude or directly as the radius (cf. Electrod. Wave-Theory of Phys. Forc. 1.134, 157-8, 1917).

Since the dilatation

$$\delta = \partial\alpha/\partial x+\partial\beta/\partial y+\partial\gamma/\partial z \qquad (74)$$

is required to fulfil the equation

$$\nabla^2(\delta - V) = 0\ *) \qquad (75)$$

where V is the potential, we see at once that the dilatation throughout the aether is similar to the potential. The potential is merely an expression for the total accumulated stress based on average amplitude of the waves, $A = k/r$, and the density $\sigma = \nu r$, and the attractive force $f = k^2/r^2 = \partial V/\partial r = -M/r^2$. This proves the Electrod. Wave-Theory of Phys. Forc. to represent the true order of nature.

Accordingly, we have the following table for the displacement or wave amplitude, density, potential and force:

Displacement or amplitude $A = k/r$	$f = k^2/r^2 = A^2 = \delta^2$
Density of the aether $\sigma = \nu r$, $\nu = 1/k$	$= \partial V/\partial r = -M/r^2$
Potential $= V = M/r$	
$V = \delta = A$.	

Since the direction of the force always is central, and the waves react towards the origin at the centre of gravity, we conclude from this whole investigation:

1. That the aether behaves as an infinite aeolotropic elastic solid, with displacements everywhere identical with the electrodynamic wave amplitude δ and also identical with the potential V. This gives a geometrical and physical significance to the potential, which hitherto has been entirely lacking, and long proved bewildering to the geometer and the natural philosopher.

2. If this were not true, the general equations for an infinite elastic solid could not have been integrated by Lord *Kelvin* as outlined above (cf. Cambridge and Dublin Mathematical Journal, 1848). But as this celebrated geometer effected such an integration for the general equations of an infinite isotropic elastic solid, without giving a physical interpretation to the solution found, we see that Lord *Kelvin*'s mathematical genius builded better than he knew, and natural philosophers are now enabled for the first time to interpret physically one of the sublimest results in the whole range of mathematical science.

Newton surmised that if the density of the aether varied directly as the distance from the centre, it would press towards the centre so as to develop the force of gravitation. *Maxwell* holds that *Newton* conceived this action as analogous to hydrostatic pressure, but we have shown that the reaction of the waves with amplitudes $A = k/r$ produces this arrangement of density and would generate an effect similar to mere hydrostatic pressure (cf. Electrod. Wave-Theory of Phys. Forc., 1.134, 1917).

Why the Forces between the Sun and Planets Operate in Right Lines: Weierstrassian Theory of the Resulting Least Action.

α) Imagine waves propagated from the sun and earth as shown in the accompanying diagram: and let the velocities of the mutually interpenetrating waves from the centres S and E be V_1 and V_2.

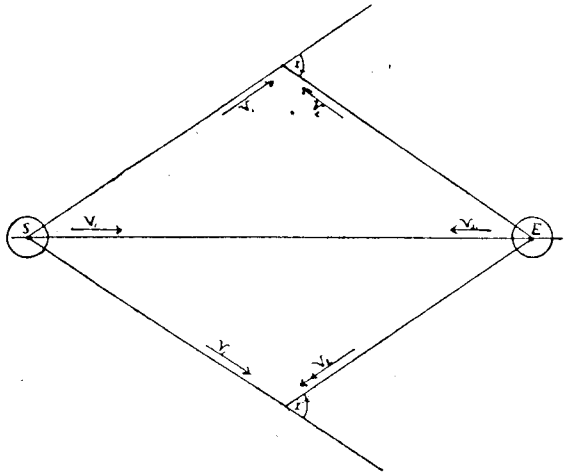
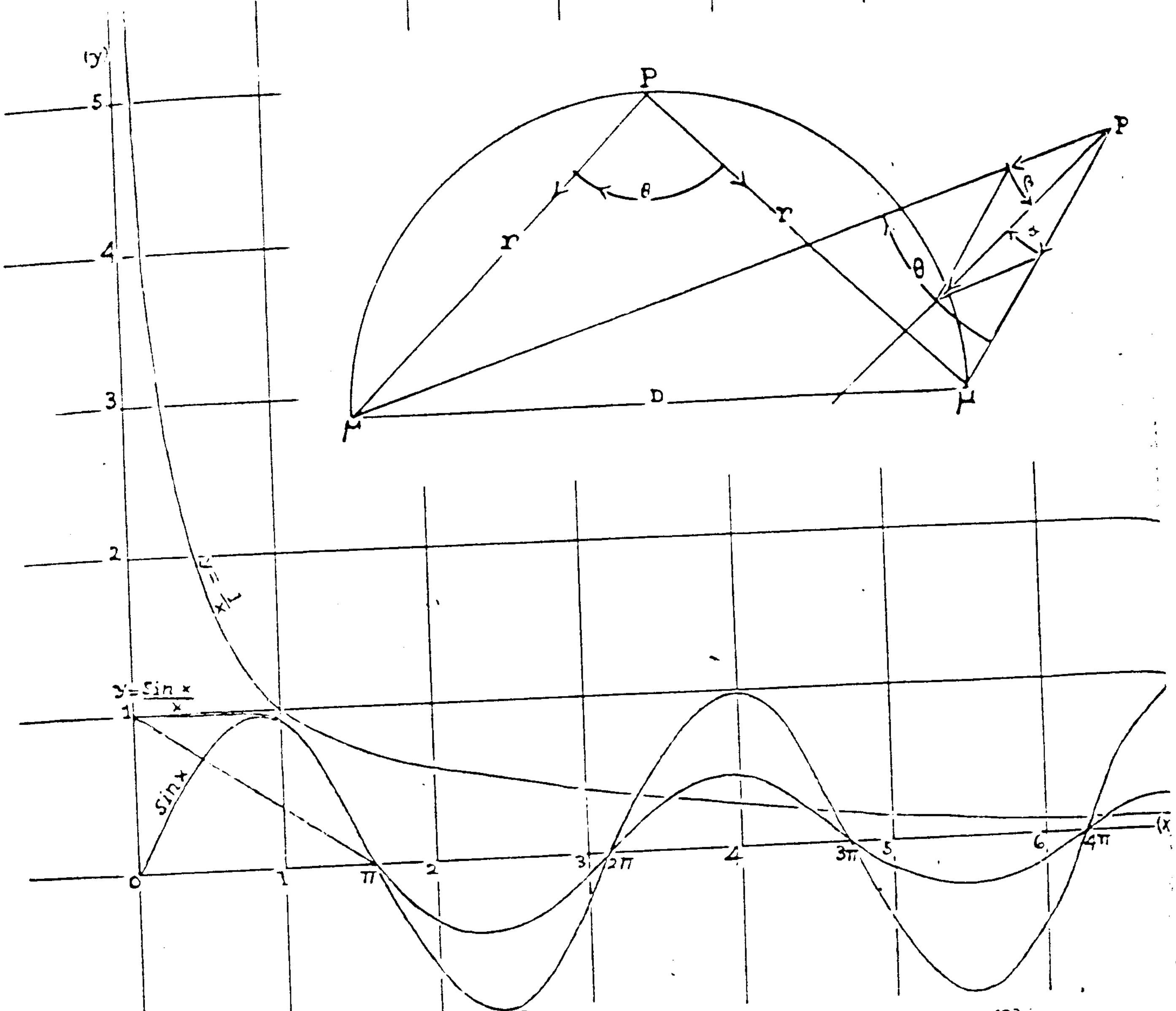


Fig. 4. Illustration of the interpenetration of waves between the sun and earth, which gives maximum tension along the line SE, where the interpenetration is with double the velocity of light.

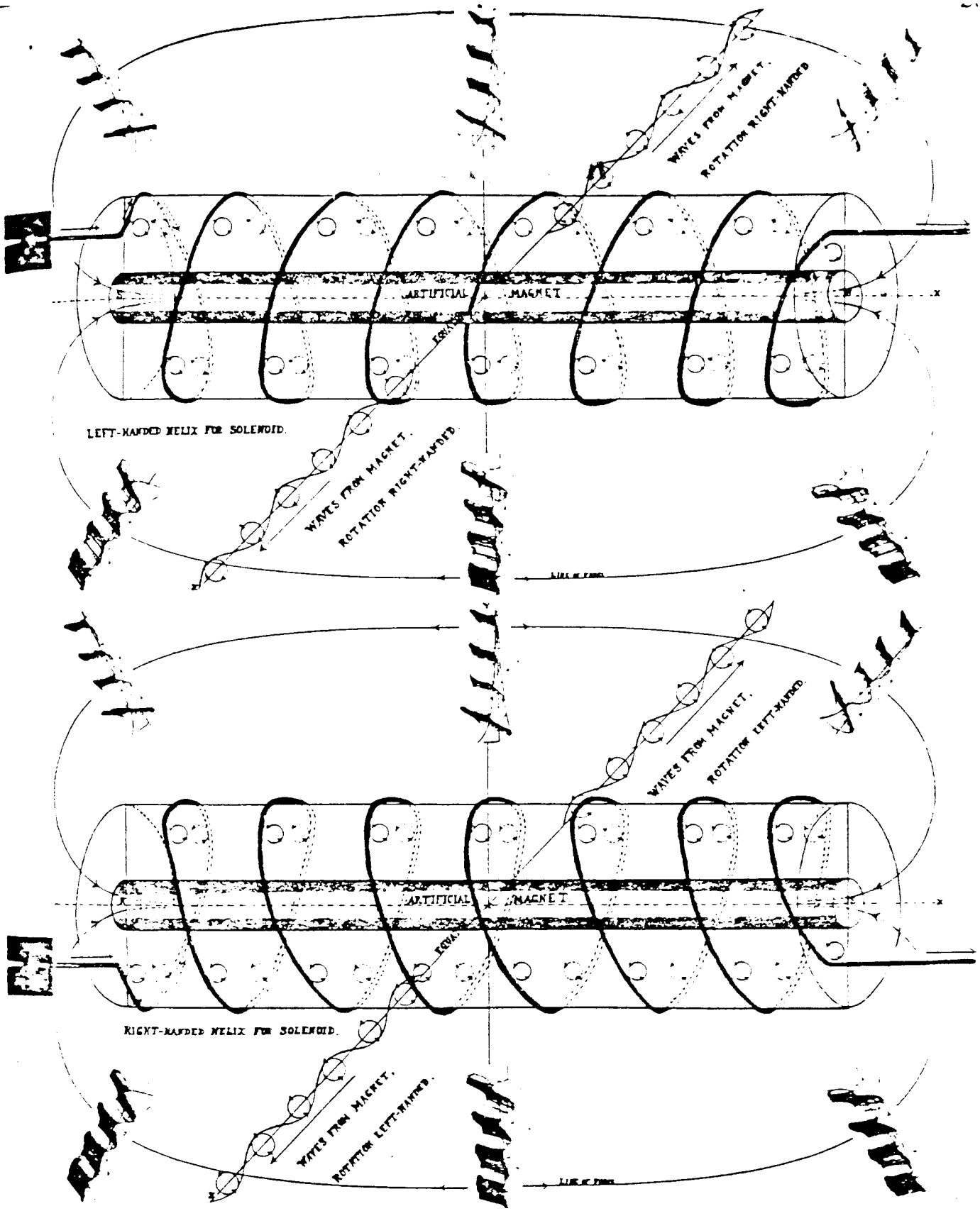
The problem arises as to the effect of the relative interpenetration of the waves, the velocities V_1 and V_2 being equal, but the amplitude and direction of propagation different at every point of space.

*) By referring to fig. 1, section 2, we see the physical meaning of this equation: the aether has dilatation, $\delta = V$, near the sun, owing to the increasing amplitude of the waves. This dilatation and decreased density of the medium exists about every star and planet.



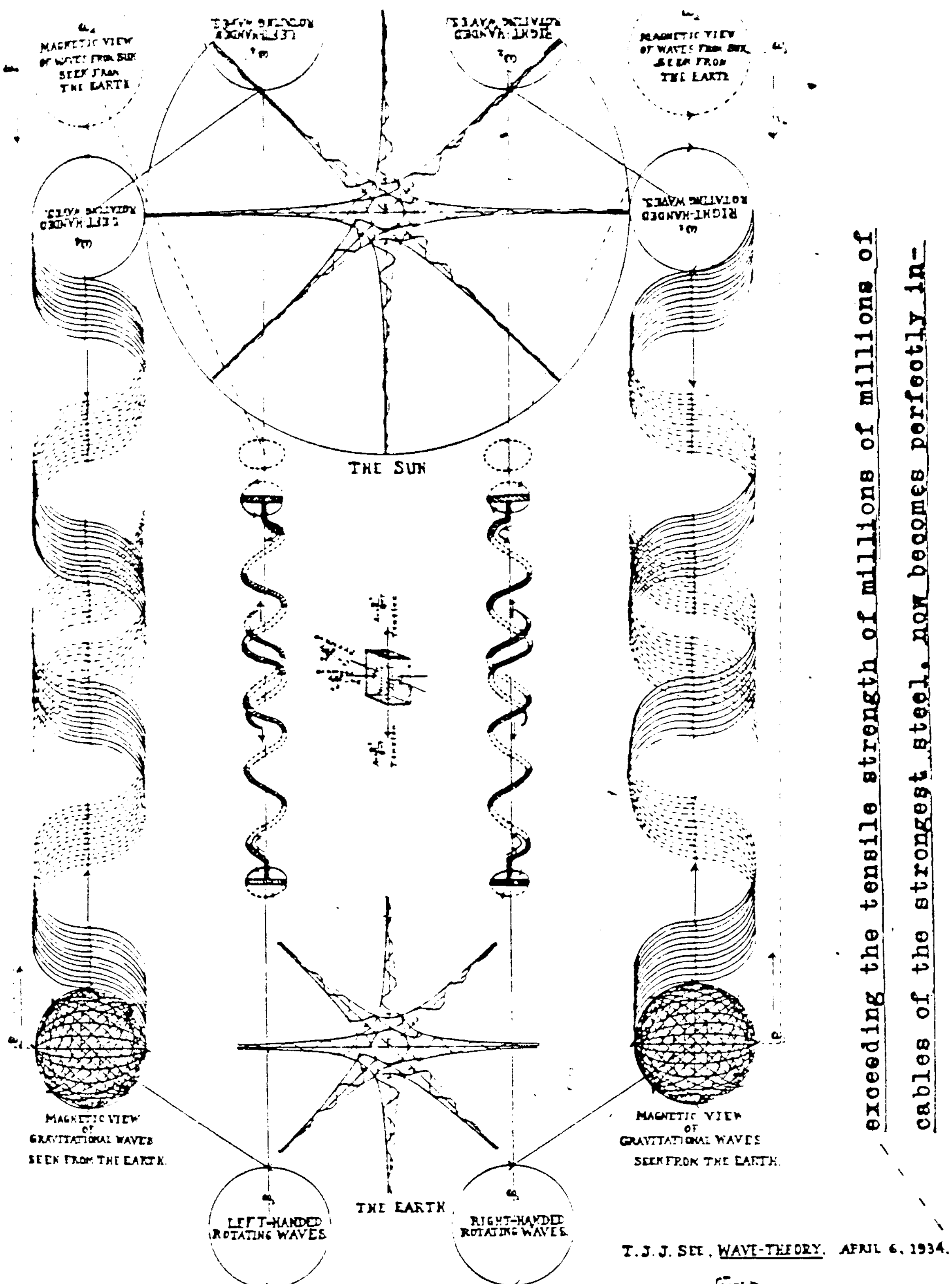
The Fourier Integral, $\int_0^{\infty} \frac{\sin x}{x} dx = \frac{\pi}{2}$, illustrated. T. J. J. See, Oct. 25. 1935.

<u>Plate I.</u> Graphical Illustration of the <u>Fourier Wave-Theorem</u> of 1802, $\frac{2}{\pi}\int_0^{+\infty} \frac{\sin p\xi}{\xi} d\xi = 1 = \frac{1}{\pi}\int_{-\infty}^{+\infty} \frac{\sin p\xi}{\xi} d\xi$, neglected in Physical Science since, for 125 years,--1802-1927; but now of universal use in the <u>Theory of Solid Bodies,</u> the <u>Sphericity of Liquid Globules</u>, with <u>Minimal Surfaces</u> of <u>Least Action</u>, for <u>Moving Waves</u>, and the <u>Spheroidal Figures of</u> the Stars and Planets. *Above* an Illustration of Vector Composition.



THE WAVE-THEORY OF MAGNETISM VERIFIED BY THE ELECTRODYNAMIC ACTION OF CURRENTS IN SOLENOIDS, WHICH WAS AMPÈRE'S METHOD OF MAKING ARTIFICIAL MAGNETS, 1820. IN VIEW OF THESE SEVERAL PROOFS THE WAVE-THEORY OF MAGNETISM IS ESTABLISHED FOREVER. T. J. J. SEE, *WAVE-THEORY*, APRIL 24, 1934.

T. Illustrating Ampère's Method for making Artificial Magnets by the [illegible] Wave-actions of Currents, 1820. The outside Waves here shown are [illegible] from the Artificial Magnet in the centre of each Coil



... VIEW OF THE GRAVITATIONAL PULLING BETWEEN THE EARTH AND SUN, UNDER FOURIER WAVES: ... THEOREM OF 1802
... WITH RIGHT-HANDED AND LEFT-HANDED ROTATIONS RESPECTIVELY, EACH GROUP EQUALLY FREQUENT, AS IN LIGHT, THE WAVES TEND
... THE OTHER PASSING WAVES OF OPPOSITE ROTATION. WAVE-AMPLITUDES TEND TO COLLAPSE. THUS THE AETHER PULLS PERPETUALLY, AS HERE
... MECHANICAL MODEL OF THE INTERLOCKED CORK SCREWS OR WAVE-HELIX. NEWTONIAN ATTRACTION ... Q.E.D.

Plate X. Illustration of the Electrodynamic View of the Gravitational Pulling between the Earth and Sun. Since the Aether is under the Universal Bursting Power of 689,321,600,000 Atmospheres, and thus of Infinite Strength, the Miraculous Pulling of the Planets, with Forces vastly exceeding the tensile strength of millions of millions of cables of the strongest steel, now becomes perfectly intelligible. Universal Gravitation no longer is the "perpetual Miracle" spoken of by Cotes in the Preface to the Second Edition of Newton's Principia, 1713.

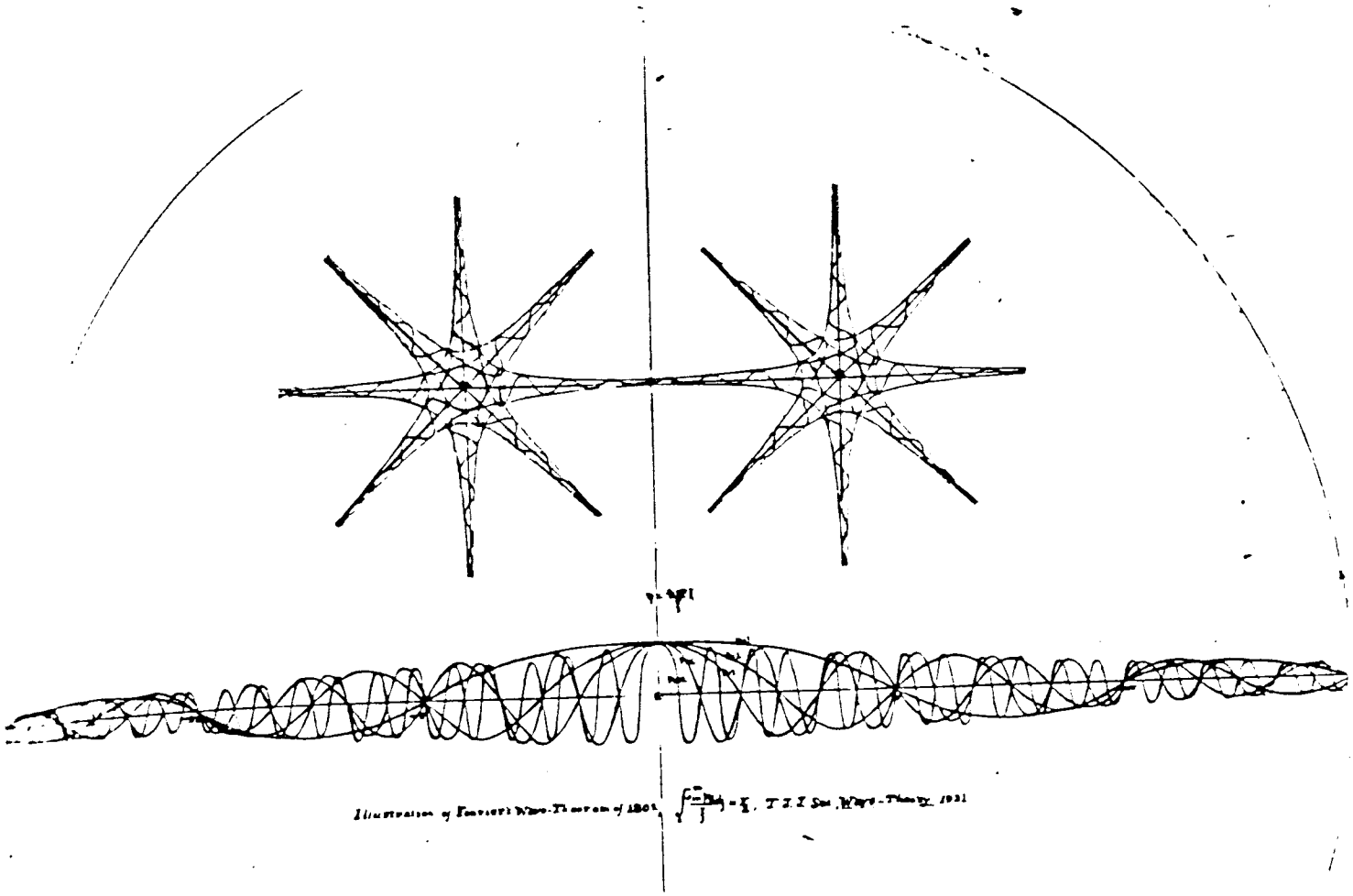


Plate II. More complete Illustration of the Fourier Waves, from every direction, and traveling in every direction, $\frac{1}{\pi}\int_{-\infty}^{+\infty}\frac{\sin f}{f}df = 1$, under balanced symmetry of Stress about a Vibrating Corpuscle or Body. In this Wave-Theorem of 1802, as Fourier shows, (Théorie Analytique de la Chaleur, section 415) the larger the multiple p , the shorter the waves, as shown in this plate. In Nature the longer waves, moving under Resistance, tend to break up into shorter waves; and hence the unlimited Gamut of Waves pervading the Universe, — this Cosmic Order having existed for millions of ages, as justly remarked by Sir Wm.Herschel, (Phil.Trans., 1785, pp213-266; Mem., 1789, pp214-226).

WAVE - THEORY!

DISCOVERY OF THE CAUSE OF GRAVITATION!

— BY —

T. J. J. SEE.

MAGNETISM, ELECTRODYNAMICS, AND OTHER FORCES OF NATURE OBEYING THE GEOMETRICAL LAW OF THE INVERSE SQUARES: WITH COMPLETE MATHEMATICAL and PHYSICAL ANALYSIS.

Based on

Fourier's Wave-Theorem of 1802, $\frac{1}{\pi}\int_{-\infty}^{+\infty}\frac{\sin P\xi\, d\xi}{\xi}=1,$

In spite of high recommendations by Nikola Tesla (who rejected Einstein's Theory of Relativity) and by the psychic Edgar Cayce and others, the "Wave-Theory of the Aether" developed in the 1920's by noted astronomer Capt. T.J.J. See has been completely ignored by modern physicists.

In summary, See explained gravitational, magnetic and electrostatic fields as longitudinal or compression waves in the aether, of approximately the same magnitude as the distances over which they operate. Light, heat and radio are described as transverse or shear waves in the aether. When the longitudinal aether waves radiating from masses couple, they produce a relative aether vacuum between them, and the bodies are pushed together (not pulled) by external aether pressure. The apparent increase of mass of an accelerating body is caused by increasing drag resistance from the viscous aether.

If a body is rotated at a certain speed, an associated aether vacuum is produced which prevents transmission of the gravitational force. This opens the way to anti-gravity levitation as demonstrated by John Searl, T.T. Brown, and Laithwaite. The theories and experiments by Charles Brush, Dr. Hans Nieper, Prof. Nipher and others also find unification in T.J.J. See's 'Wave Theory of the Aether.'

In an article written by Nikola Tesla and published in Telegraph & Telephone Age (Oct. 16, 1922), the great inventor described his Magnifying Transmitter and Earth resonance. Tesla mentioned Capt. See's theory and expressed his agreement with it:

"The law of motion can be expressed by stating that the waves on the terrestrial surface sweep in equal intervals over equal areas, but it must be understood that the current penetrates deep into the Earth and the effects produced on the receivers are the same as if the whole flow was confined to the Earth's axis joining the transmitter and the antipode. The mean surface speed is thus about 471,200 kilometers per second --- 57% greater than that of the so-called Hertz waves --- which should propagate with the velocity of light if they exist. The same constant was found by the noted American astronomer Capt. T.J.J. See in his mathematical investigations, for the smallest particles of the ether which he fittingly designates as 'aetherons'."

T.J.J. See published a 13-volume set of books titled 'Wave-Theory: Discovery of the Cause of Molecular Forces (Magnetism, Electrodynamics, and Other Forces of Nature Obeying the Geometrical Law of Inverse Squares...)' which is exceedingly rare today. He also published a series of eight papers in the journal 'Astronomische Nachrichten' which are more accessable. These have been retrieved by and are available today from Rex Research.

T.J.J. SEE's WAVE-THEORY OF THE AETHER

Papers #1-8 from Astronomische Nachrichten, circa 1920.

First Paper (A.N. #5044, Vol. 211): 'New Theory of the Aether'

The Medium of the Aether is necessary for conveying Physical Action across Space...New Law of the Density & Rigidity of the Aether...Relation between Mean Molecular Velocity of a Gas & that of a Wave Transmitted in such a Medium...Elastic Power of the Aether...Table of Physical Constants of the Aether...The Aetherion...Explanation of the Propagation of the Wireless Waves around the Earth...Outline of the Wave Theory for Magnetism, Attraction & Repulsion...The Aether as an Infinite Aeolotropic Elastic Solid propagating Waves...Confirmation of Wave Theory by Lord Kelvin's Integrals of 1848...Geometric and Physical Conditions which the Forces generated must satisfy.....

Second Paper (A.N. #5048, Vol. 211):

Gravitational Action propagated with the Velocity of Light...Electrodynamic Wave-Theory of Physical Forces explains Motion of Perihelion of Mercury...Modification of Newtonian Law...Outline of the Cause of the Fluctuations of the Moon's Mean Motion...Gravitational Action is propagated by Stresses due to Waves in the Aether...Geometrical Conditions fulfilled by the Velocity-Potential $\emptyset$...The Kinetic Theory of the Aether accords with the Views of Newton & Maxwell...New Theory of Stellar Aberration based on the Motion of Light relatively to the moving Earth...Sir Oliver Lodge's Experiments for detecting the Viscosity of the Aether, & Fitzgerald's Hypothesis.
.....

Third Paper (A.N. #5079, Vol. 212):

Two Remarkable Theorems on the Physical Constitution of the Aether... Geometric & Physical Outline of the Relationship between Light, Magnetism and the Electrodynamic Action of a Current...Plane Waves of Magnets & the Law of Amplitude...High Velocity of the Electron under Charge explained by Acceleration due to Aether Waves....Aetherial Identity of the Velocity of Electric Waves with that of Light...Aetherions & "Electrical Mass"... Kinetic Wave Theory of Aether and the larger Problems of the Universe.....
.....

Fourth Paper (A.N. #5048, Vol. 213):

Isotropic Aether & Radial Motion...Maxwell's ElectroMagnetic Theory of Light is incomplete...Geometrical Reasons why the Vibrations of Ordinary Light are mainly Transverse...Fundamental Objections to Fresnel's Theory of Linear Polarization of Reflected Light...Undulatory Explanation of the Phenomenon of Interference in Polarized Light...New Wave-Theory of Light accounts for all known Optical Phenomena...Wave-Theory of Gravity & Geometrical Theory of Confocal Conics.....

Fifth Paper (A.N. #5130, Vol. 214):

Outlines of Wave-Action Theory of Molecular Forces...The Rainbow in light of the Wave-Theory...New Theory of Surface Tension & of Capillarity based on Wave-Action...New Theory of Lightning...Droplets & Bubbles... Capillarity...Wave-Theory in Relation to Planck's Quantum Theory...Postscript.
.....

Sixth Paper (A.N. #5140, Vol. 217):

Wave-Theory of Chemical, Explosive, & Vital Forces...Development of Heat in Chemical Reactions as a Proof of the Wave-Theory...Geometric Basis of the Atomic Arrangement in the Wave-Theory & the Source of Power in High Explosives...Radioactivity & Orgainc Growth...Direct Evidence of Wave Theory... Conclusion...Part Two: Discovery of the Cause of Universal Gravitation... Rigorous Geometric Analysis confirms Tension in the Aether between 2 Stars... The Cause of Universal Gravitation...Summary of Chief Results of the New Theory of the Aether...The Tension of the Aether: Wave-Theory & the Newtonian Theory of Central Force directed to the Focus of the Conic Section...Postscript... .....

Seventh Paper (A.N., Vol. 217, Oct. 22, 1922):

Discovery of the Cause of Magnetism & of a Remarkable Connection between Magnetism & Universal Gravitation...New General Formulae for the Intensity of the Ponderomotive Force in the Magnetic Field...Verification of Biot's Law: an Experimentum Crucis as to the Nature of Magnetism... Investigation of the Supposed Motion of the Magnetic Poles in the Earth... Theory of Earth's Magnetic Moment...Gauss' General Theory of Earth's Magnetism ...The Mutual Potential Energy and the Mutual Action of Two Magnetic Systems... Velocity of the Propagation of Universal Gravitation...Explanation of the Periodic and Secular Changes in Earth's Magnetism...Conclusion..... .....

Eighth Paper (A.N., Vol. 226, Feb 27, 1926):

A Supplement of the Discovery of the Cause of Gravitation ---Part One: Analysis of the Progress of the Problem...An Investigation of the Physical Cause underlying the Forces of Nature which follow the Law of Inverse Squares... Part Two: Geometrical & Physical Explanation of the Law of Inverse Squares... Observational proof of the Existence of Electrodynamic Waves from the Sun, Moon & Planets...Geometrical & Physical Significance of Laplace's Potential Function V: Lagrange's Force Function U, for Newton's Law of Mutual Attraction... Explained by Wave-Action...Wave-Effect of Tension between and Pressure behind 2 Centres of Disturbance...Confirmation of Wave-Theory of Universal Gravitation by Definite Laboratory Experiments...Part Three: Velocity Potential of $\emptyset$ with the Solution of the Fourier-Poisson Potential for Waves in the Aether... Some Geometrical & Physical Grounds for Wave-Theory representation of the True Order of Nature...Investigation of an Infinite Integral arising in the Wave-Theory of the Aether as applied to the Stars... Numerical Example of an Analogous Method of Integration by Successive Approximations..... Part Four: Theorems of Laplace & Poisson on the Invariability of the Major Axes & Mean Motion of the Planets generalized for all the Higher Powers of the Masses...Brief Criticism of Certain Traditional Theories...Concluding Note on the Lunar Theory..... .....