Recorded at the Cheltenham Magnetic Observatory,'' O. H. Tittmann; ''The Magnetic Character of the Year 1912,'' G. van Dijk.

SPECIAL ARTICLES

TRANSFORMATION OF GRAVITATIONAL WAVES INTO ETHER VORTICES

On a number of occasions since 1890, when I first published my electrostatic doublet theory of cohesion, Science has been so good as to afford me the opportunity of making public the results of my investigations along this and other lines.[1] A brief account of some later work on the origin of vortex systems, accomplished during the past five or six years, may be of interest.

In the above-mentioned series of papers it was shown that all electrical and magnetic phenomena known could be mathematically derived from a system consisting of a single vortex filament in a frictionless fluid, and that gravitation was a compressional elasticity phenomenon in this fluid.

Now this single vortex filament, while satisfactory from the mathematical point of view, so far as all *known* phenomena go, is not equally so if, as we may suspect, the universe is conservative. There is a gap in the cycle. Also, while the single vortex filament appears to be forced upon us by the difficulty of forming any plausible idea of an action which would lead to a filling of the universe with a number of exactly similar vortices, yet if such an action could be formulated it would be more satisfactory, on the ground of probability, than the concept of the single vortex.

While still incomplete, the work above referred to as having been done since 1900, and mostly within the last five years, has given results which are quite satisfactory in regard to both the above-mentioned points. Put briefly, it would appear that gravitational waves shed off a portion of their energy as vortices, and that these vortices are of exactly

similar nature irrespective of the intensity of the wave.

In my search for a satisfactory theory to account for the apparently exact similarity of vortex singularities in the ether I came again to Lord Rayleigh's discussion[2] of the difficulty in the equations for the propagation of plane sound waves (which difficulty was first pointed out by Stokes).[3]

According to these equations, the motion of a plane wave becomes after a time discontinuous. Stokes suggested (and Lord Rayleigh considered it probable) that some sort of reflection took place when the motion became discontinuous. Rayleigh also states that divergence would possibly prevent the occurrence of discontinuity, but my work seems to show that there is no beneficial effect caused by divergence; Rayleigh, Taylor and others have pointed out that viscosity would tend to prevent discontinuity.

Some time previously I had done considerable work, in connection with yacht designing, on the discontinuity of flow with the slipping of water along the side of a moving vessel; on the electromagnetic rotation of light in absorbing bodies;[4] and on the reflection of electric oscillations in electric wires with lumped capacity and inductance,[5] all of which work had at some point or other led up to discontinuities, when treated in the regular way, but all of which could be made to give, beyond the point of discontinuity, two part solutions, one part consisting of a diminished flow or wave intensity, and the other of an imaginary part which was interpretable as a vortex, sometimes oscillating, and sometimes conjoined with reflection.

This was at least suggestive, and on a careful examination of the difficulty referred to by Stokes and Lord Rayleigh in the equations for the propagation of plane waves, it was seen that the essential thing necessary to keep the wave from becoming discontinuous was that *it should shed off a certain fractional part of*

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[1] ''Further Developments of the Electrostatic Doublet Theory of Cohesion,'' Science, July 22, 1892, and March 3, 1893; ''Determination of the Nature and Velocity of Gravitation,'' Science, November 16, 1900, etc.

[2] Rayleigh, ''Sound,'' Vol. 2, p. 35.

[3] *Phil. Mag.*, November, 1848.

[4] *Phys. Rev.*, March, 1900.

[5] U. S. patent 706,738, 1901.

its energy, and that it did not matter how it did it, whether by viscosity or hysteresis or heat conduction or reflection or vortex motion. (I omit divergency because the only functions I can find connected with divergency which would prevent discontinuity either vanish at a short distance from the source, or only exist at the lateral edges of the wave, and hence do not affect spherical waves.)

Now in a fluid like the ether, viscosity, hysteresis and heat conduction losses can not occur. Nor, if my work is correct, can reflection occur without vortex motion, and then not necessarily.

But the vortex motion is a necessity, in a fluid like the ether, whenever a spherical wave reaches a certain distance from its source. And gravitational waves must therefore give rise to vortices in the ether.

And the satisfactory point about these vortices is that they are exactly similar, irrespective of the intensity of the gravitational wave, and dependent only upon the elasticity and density of the medium. This therefore relieves us of the necessity of assuming a single vortex filament.

There are some points still to be cleared up. For example, one might anticipate that the rotational velocity of the vortices would be the same as the translational velocity of the wave, but there appear to be at least one, and possibly two, other types, with rotational velocities of the square and cube root of the wave velocity; also in some respects the motion of what I have called the oscilla appear to differ from that of our standard vortex filament. All this is at present rather hard to interpret, but doubtless, as the difficulties of the analysis are gradually overcome, we shall be able to visualize the system more clearly.

As the work is still under way, the above results would not have been published but for the fact that it appears to have been generally assumed at the last British Association meeting that Planck's "quanta" theory and Maxwell's continuous medium theory are mutually exclusive and that one or the other must be given up. Now the results referred to above show that this is not so, but that every continuous medium theory *must* involve quanta, and we might almost say that a continuous medium begins to count as soon as it gets its legs. A unit quantity is, therefore, just as natural a thing as a flux; and in this connection it is interesting to note how, from Newton and Leibnitz down to Maxwell and Planck the English mind runs always to continuities and fluxes and the German to quanta and infinitesimals.

It may also be pointed out that quanta are a necessary consequence of motion due to central attraction. One visible example of this is the gaps in Saturn's rings. These are due to satellite resonance, but I have found that nucleus resonance gives quanta,[6] whether the resonant nucleus be the sun or the positive electron. The latter case is much the simpler, as all the corpuscles are the same size and so what we may call the "quanta orbits" are simpler.

From the above it will be seen that the problem of the transmission of plane waves in a frictionless fluid is not, as has been generally assumed, a matter of no practical importance and of interest to pure mathematicians only. But that it is a matter of very great practical importance, and that the complete solution of the problem is of capital importance in many fields, from the design of aeroplanes and the calculation of frictional resistance of ships to the theory of the constitution of the ether and the structure of the positive charge.

<div align="right">Reginald A. Fessenden</div>

THE SPECIFIC GRAVITY OF SILT[1]

In a report recently published by the Department of State, entitled "Silt in the Rio Grande," certain fundamental ideas are promulgated, concerning the specific gravity of silt which seemed to the writer incorrect, and of sufficient importance to be worthy of a brief note in Science.

The author, W. W. Follett, consulting engineer of the International Boundary Commis-

6 See also some of Darwin's papers.

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