## A New Take on Gravitational Waves.

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**Abstract.**

Following recent announcements concerning the detection of gravitational waves and the accompanying claims that this offers further proof of the validity of the theory of general relativity, here some long forgotten work showing that the existence of such waves was predicted in the very early years of the last century and had been hinted at even before that is brought to light. Yet again the question of whether or not a piece of experimental work establishes the place of general relativity in modern physics is raised.

**Introduction.**

Recently claims have been made concerning the detection of so-called gravitational waves. In fact, the first claims were announced by the LIGO and Virgo collaborations in 2016[1,2] following claimed direct observations made towards the end of the previous year. Alongside these published results has been the additional claims that such waves were predicted by Einstein's General Theory of Relativity and their detection as another triumph for that theory. It must be noted that theoretical issues and specific problems concerning the reliability of the experimental apparatus and the interpretation of collected data lead to questions concerning exactly what was measured and recorded.[2a,2b] However, accepting that the claimed detection of such waves is true, does it necessarily follow that this provides further solid vindication for general relativity? One of the major problems facing anyone concerned with justifying the validity of general relativity as a theory crucially central to most, if not all, of modern physics has always been the fact that the theoretical results leading to the need for carrying out various well-known tests have always been derivable by means not necessitating the use of any techniques associated with general relativity. Delving into theory developed before the important year of 1905 would seem to indicate that such is the case here. One problem many have faced in believing in the existence of gravitational waves has been the belief that it was rooted in general relativity and many were always dubious of the need for this theory. An examination of the works of several eminent theoreticians of earlier years shows that the notion of gravitational waves was predicted and under serious consideration long before the advent of the theory of general relativity.

**Whittaker.**

The name of Edmund Whittaker is familiar to many. Countless students have learned much from the book he co-authored with Watson on Modern Analysis[3] while his two volume work on a history of the theories of Aether and Electricity[4] has proved of inestimable value to many scientists both as a reference text and as a source of inspiration for researchers and historians of science alike. However, although obviously a well-known and well-respected member of the academic community, some of his important papers have seemingly been ignored or carefully forgotten. Among these is his wonderfully detailed work on solutions of partial differential equations of mathematical physics[5], a piece all the more worthy of investigation given the author's extreme knowledge of the topic as evidenced by his aforementioned book on modern analysis. Although the entire paper is, or should be, of interest to all, it is the final section in which he considers the explanation of gravitation and electrostatic attraction as modes of wave disturbance which is of the utmost relevance here. Earlier in the article he has shown that any solution of the equation

$$\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}+\frac{\partial^2 V}{\partial z^2}=k^2\frac{\partial^2 V}{\partial t^2} \qquad (*)$$

may be analysed into simple plane waves. He goes on to point out that this throws new light on forces, such as gravitation, which vary via an inverse square law. This is due to the fact that such forces have a potential which satisfies the equation

$$\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}+\frac{\partial^2 V}{\partial z^2}=0$$

and must, therefore, satisfy equation (*), where $k$ is any constant. He goes on to point out that this potential may be analysed into simple plane waves. He then proceeds to comment that it is not difficult to construct systems of coexistent simple waves possessing the property that the total disturbance at any point varies from point to pointy but does not vary with time. He illustrates this by considering a particle emitting spherical waves such that the disturbance at a distance $r$ from the origin at time $t$ due to those waves whose wave-lengths lie between $2\pi/\mu$ and $2\pi/(\mu+d\mu)$ is represented by

$$\frac{2d\mu}{\pi\mu}\frac{sin(\mu Vt-\mu r)}{r}$$

where *V* is the velocity of propagation of the waves. After the waves have reached the point *r*, so that (*Vt* – *r*) is positive, the total disturbance at this point is

$$\int_0^\infty \frac{2d\mu}{\pi\mu}\frac{sin(\mu Vt-\mu r)}{r}=\frac{1}{r}$$

that is, the total disturbance at any point , due to this system of waves, is independent of time and is proportional everywhere to the gravitational potential due to the particle at the point.

He continues by making it clear that this indicates that the field of force due to a gravitating body may be analysed into an infinite number of constituent fields and, although the whole field of force does not vary with time, each of the constituent fields has an undulatory character consisting of a simple wave disturbance propagated with uniform velocity. In each of the constituent fields the potential will be constant along each wave front and consequently the gravitational force in each constituent field will be perpendicular to the wave front – that is, the waves will be *longitudinal*. Crucially, from the point of view to be considered here, these considerations of 1903 link the propagation of gravity with that of light. As Whittaker stresses, this does not explain the cause of gravity but what has been achieved is to show that to account for the propagation of forces which vary as the inverse of the square of the distance across space, it is necessary only that the medium be capable of transmitting simple periodic undulatory disturbances similar to those whose propagation by the medium constitutes the transmission of light. Of course, it is possible that effects registered by these sensitive instruments in the relatively recent observations could reflect something other than that claimed in those usual interpretations of the data.[1,2,2a] It is possible that changes in the experimental apparatus affecting the propagation of light are brought about by such undulatory alterations in the density of the medium through which light travels, noting the time independent nature of the entire field of force.

However, in 1903, long before the advent of general relativity, Whittaker had already suggested the possibility of the existence of gravity waves. To some extent, though, even he had been preceded in this by Heaviside[6] who, noting the form of the two fundamental accepted equations describing the gravitational field, had postulated the existence of two more similar equations to bring his gravitational theory into line with electromagnetism and especially with the then agreed four Maxwell equations of that discipline. Given that such a set of equations would imply a wave equation, as in traditional electromagnetic theory, once again the existence of gravitational waves is implied. Of course, in Heaviside's case the nature of the second field was not specified although, as Brillouin[7] points out, when Carstoiu[8] raised the same question years later, he suggested the second field be a gravitational vortex.

**Thornhill.**

In the present context it is worth drawing attention yet again to the somewhat later work of Thornhill[9]. In this article, he proved conclusively that, in a gas-like aether, the duality between the oscillating electric and magnetic fields (which are transverse to the direction of propagation of the electromagnetic waves) becomes a triality with the longitudinal oscillations of the aether motion if electric field, magnetic field and motion are both coexistent and mutually perpendicular. This drew on the results of his earlier article[10] in which he discussed at length the kinetic theory of electromagnetic radiation, deriving also a value for the mass of an aether particle. Although Thornhill's work relates particularly to the Maxwell equations for an electromagnetic field, if Carstoiu's idea of a set of analogous equations to describe the gravitational field holds then Thornhill's analysis will apply to this set of equations as well. As has been pointed out before[11], one of the problems with Carstoiu's equations is whether or not it is valid to assume the existence of a second field – his so-called gravitational vortex. Again though, as discussed previously, whether or not such a second field exists has no bearing on the existence of longitudinal, or scalar, waves since their existence does not depend on the existence of a second field. Incidentally, again as has been shown[11], this is true for the Maxwell electromagnetic equations also – longitudinal waves are found to exist if the ***B*** field is zero whether or not the ***E*** field is zero too. It follows immediately that, in the gravitational situation, scalar waves appear regardless of whether there is a second field or not because to realise them you may simply assume the existence of such a field and then put it equal to zero!

Hence, yet again a discussion of the existence of gravitational waves is found in work which is not related to the theory of general relativity and has no need to draw on results from that theory to either deduce or substantiate the existence of such waves.

**Conclusions.**

Obviously it is seen immediately that there is no need to invoke ideas of general relativity to introduce the notion of gravitational waves. Indeed, for some sceptics this deduction above may induce them to believe in such waves. Once again though, a result which supposedly places general relativity of a firmer footing in modern physics is found to do no such thing; like all the other 'tests' it is found that the required results are deducible from mathematics and physics of a pre-relativity era. This raises the far more worrying and wider question of how much good, relevant, detailed physics of the nineteenth and very early twentieth centuries has been conveniently forgotten. This is a serious genuine question deserving of a serious genuine reply. It is not something emanating from a deep conspiracy theory but rather a question arising from a detailed examination of some exceptionally good articles by truly eminent scientists of a bygone time. How much more remains for us to uncover for our benefit from that earlier time?

As a final point, it is possibly of interest to note that, as has been said many times before in both the cases discussed above – those of Whittaker and Thornhill – the people concerned were highly proficient mathematicians who also had a deep understanding of the physics of the situations with which they were dealing. In both cases it may be claimed that the physical deductions were not dictated by the mathematics; rather the two blended together to provide a complete picture of the situation under consideration. In a true sense here were two cases of mathematics being used as a useful tool for dealing with a physical problem. This is something which should be remembered – when dealing with any physical problem, mathematics is simply a tool enabling a solution to be found but throughout it is the physics which must remain of paramount importance.

**References.**


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