Gravitational Waves Detection through Electromagnetic Waves, Frequency shift, or Induced Current Measurement

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Abstract

We propose two novel techniques for detecting gravitational waves. First technique is based on detecting electromagnetic waves generated through oscillating dipoles formed by separated charges on capacitor plates kept perpendicularly to incoming gravitational waves, in the y-z plane say. We keep two parallel plate charged capacitors in the y-z plane, kept perpendicularly to each other with plates kept perpendicularly to y-z plane and let the separation between plates be d say. When plane gravitational waves will be passing this apparatus by falling perpendicularly on y-z plane there will be switching of direction of elongation and contraction periodically in such a way that there will be elongation along y-direction and contraction along z-direction and then the reversal of these conditions, i.e. there will be contraction along y-direction and elongation along z-direction. Due to this the separation between these fully charged parallel plates will be changing periodically. This variation will essentially amount to formation of several oscillating dipoles which will emit electromagnetic waves. If these electromagnetic waves could be found then their existence will conclude the arrival and passing of gravitational waves! Alternatively with the same setup can be utilized based on variation in the value of capacity of the above mentioned parallel plate capacitors connected with suitable inductors and a power supply forming a resonant LC circuit and measuring the shift in the resonant frequency. If detectable shift in the resonant frequency will be found due to variation in the value of capacity with variation in the value of separation between the parallel plates of the capacitors then this will imply the successful detection of gravitational waves! The second technique we propose is based on replacing usual suspended Weber bar by a strong magnet and keeping a fixed helical solenoid around this strong magnet and connecting two ends of this solenoid wire two current meter to measure the induced current. When the magnetic Weber bar will oscillate in response to passing gravitational wave there will be change in magnetic flux producing induced current in the solenoid coil. If detectable current will be found to be induced in the coil then again this will imply the successful detection of gravitational waves!

1. **Introduction:** Experimental detection of gravitational waves is a big challenge of this time and enormous efforts are on world over by people working in highly sophisticated gravitational wave detection laboratories. Gravitational wave laboratories will be leading laboratories in the coming future to offer new important insights in our study of large scale phenomena. Detection and study of gravitational waves of different types and of different intensity and frequency will make

revolutionary contributions to our knowledge about galactic dynamics. It will add greatly to our knowledge about astrophysical sources and about processes driven by strong gravitational fields. Objects of fundamental importance, such as astrophysical black holes, merge and radiate with luminosity larger than the entire electromagnetic universe, and these events will become clearly detectable only through a tool for detection of gravitational waves that are mainly associated with detectable amplitude with such unimaginably huge events [2]. When observed with gravitational waves these intrinsically interesting astronomical sources such as massive black holes and their merger, extremely compact stellar binaries and their collisions, supernovae events etc will surely yield many new surprises. Thus, the discovery potential associated with detection of gravitational waves is immense.

Gravitational radiation was detected indirectly in 1974 by J. Taylor and R. Hulse, who observed its effects on the orbital period of a binary system containing two neutron stars, one of them a pulsar (PSR 1913 + 16). Efforts to detect gravitational waves directly have been severely challenged by the extreme weakness of the waves impinging on the Earth. However, as the 21st century begins, observations of the gravitational waves from astrophysical sources such as black holes, neutron stars, and stellar collapse are expected to open a new window on the universe [3].

There are two major gravitational wave detection concepts: acoustic and interferometric detection [4]. The acoustic method deals with a resonance response of massive elastic bodies on gravitational wave excitations. Historically the acoustic method was proposed first by J. Weber [1] where he suggested using long and narrow elastic cylinders as Gravitational Wave Antennas. Although a significant progress has been achieved in fabrication and increasing sensitivity of such type of detectors [5, 6, 7] the interpretation of obtained data is still far to claim undoubtedly the detection of gravitational waves. Extraordinarily weak effect produced by gravitational waves requires exceedingly high detector sensitivity for both acoustic as well as interferometric detectors. Any new idea associated with marked improvement causing increase, may be in the indirect way, in the size of the quantity to be measured for getting conclusive evidence for the presence of gravitational waves will be a welcome thing.

2. **Detection through Detecting EM Waves or Frequency Shift:** In the first technique we propose to detect possible emission of electromagnetic waves from several dipoles that are set in oscillation in unison on arrival and passing of gravitational waves or through detecting shift in the resonance frequency of an LC oscillator arrival and passing of gravitational waves with the help of the following experimental arrangement. As shown in FIG.1 below we fix parallel to each other oppositely charged plates of parallel plate capacitor, two plates perpendicularly to y axis and two other perpendicularly to z axis. As long as this system is not exposed to any gravitational wave there will be no deformation of any kind, i.e. extension or contraction of distances between the parallel plates of two capacitors fixed as described above. Now, suppose plane gravitational waves start passing along x axis and falling perpendicularly to y-z plane. Now the deformations will be introduced, i.e. there will be periodic switching of directions of elongation and contraction in such a

way that when there will be contraction along y-axis there will be elongation along z axis and vice versa. This periodic switching of directions of contractions and elongations leads to formation of several oscillating dipoles because of charged plates of the capacitors. These several dipoles oscillating in unison will cause emission of electromagnetic waves with measurable intensity and when detected will indirectly prove existence of gravitational waves!

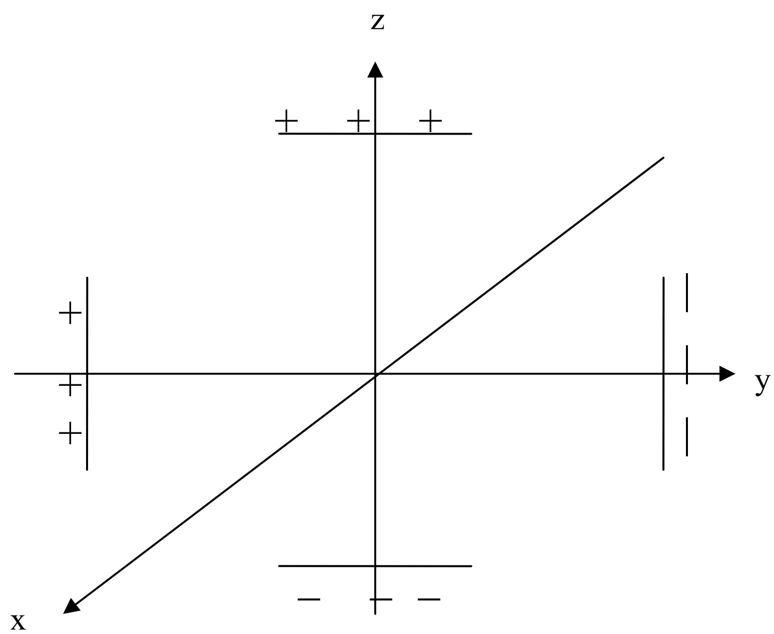

FIG.1

As an alternative technique we further wire the capacitors arrangement shown in FIG.1 to join them separately to two inductors of identical value and form two LC oscillators. As long as these circuits are not exposed to any gravitational wave there will be no deformation of any kind, i.e. extension or contraction of distances between the parallel plates of two capacitors fixed as described above and these oscillators will resonate with exactly identical resonant frequency. Now, suppose plane gravitational waves start passing along x axis and falling perpendicularly to y-z plane. Now the deformations will be introduced, i.e. there will be periodic switching of directions of elongation and contraction in such a way that when there will be contraction along y-axis there will be elongation along z axis and vice versa. Due to this periodic change in the distance between the parallel plates of the capacitors the value of capacity will change periodically and the resonant frequencies of two oscillators will differ in value periodically, i.e. the resonant frequencies will be such that initially first oscillator will have lesser value of resonance frequency than the other, then at some later instant both the resonance frequencies will become equal and again at some later instant first oscillator will have larger value of resonance frequency than the other. This will continue to happen periodically as long as the gravitational waves are passing through the apparatus. The detection of occurrence of periodic shift in the resonance frequency will give us indication of incidence and passing of gravitational waves!

3. **Detection by Detecting Weak Induced Current:** We replace usual Weber bar by a strong bar magnet. We take a helical coil having rigidly fixed position around this suspended magnetic Weber bar. The main idea in brief behind this second technique suggested in this paper is to detect weak induced current. We set up suitable circuit for amplifying this weak induced current. This weak current is induced due to change in the magnetic pole positions with respect to fixed helical coil wound around this suspended magnetic Weber bar due to the periodic contraction and extension of this freely suspended magnetic Weber bar. Because of periodic variation in length of resonating magnetic Weber bar and so variation in pole positions of this strong bar magnet with respect to fixed solenoid coil wound around and kept at small distance causing in turn the change in the magnetic flux causing the detectable induced current while gravitational waves will pass through the apparatus. When this induced alternating current will be suitably amplified we have achieved the signature of the presence of gravitational waves. This idea is inspired by the simple experiments conducted by Michael Faraday while he demonstrated electromagnetic induction for the first time and demonstrated that induced current is in fact proportional to change in the magnetic flux associated with moving magnet through fixed coil. In our case here, we will be using this same techique based on using induced current to detect and measure the variation in the length of magnetic Weber bar due to its periodic expansion and contraction while a gravitational wave will be passing throught the apparatus. We suggest to measure variations in length of magnetic Weber bar through variation in induced current as the suspended antenna oscilates causing change in its length. The detection of occurrence of the induced alternating current will give us conclusive indication of incidence and passing of gravitational waves!

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