Do measurements of the propagation speed of low-frequency Gravitational Waves confirm the existence of Gravitons?

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Gravitational waves with frequencies above 50 Hz propagate at the speed of light. To date, there have been no measurements at lower frequencies. Analyses show that records of the atmospheric pressure at significantly lower frequencies contain signals from extraterrestrial sources. These are phase-modulated, and the propagation speed depends on the frequency. If the waves are GW, the measurements could confirm the existence of gravitons and allow a mass determination. The results of previous work are summarized here.

1 Introduction

In gravitational wave astronomy, it is important to understand how gravitational waves propagate. The simultaneous observation of gravitational waves from the coalescence of two neutron stars and its gamma ray counterpart (GW170817 and GRB 170817A), has shown that the propagation speed of gravitational waves at frequencies above 100 Hz is as large as the speed of light. Therefore, the presumably existing gravitons should have negligible mass. To test this assumption, we developed a method to measure the speed of the GW at lower frequencies, where the mass of the gravitons has a greater influence. Interferometers are useless because they do not provide usable data below about 20 Hz.

Numerous highly sensitive measuring instruments such as gravimeters and barometers are in continuous use around the world, collecting data every minute. They register a mixture of signals from a wide variety of sources and frequencies, with occasional disturbances, such as earthquakes. Ignoring all frequencies caused by the movement of neighboring celestial bodies [1], numerous very weak spectral lines remain, whose frequencies are almost constant and whose amplitudes barely change for decades.

Since all suspect signal frequencies change cyclically at a 365-day rhythm, the signal sources lie outside the solar system. A comparison of the signal frequencies with the orbital periods of binary star systems suggests that the signals are generated by the binary stars themselves. Binary systems are very numerous in our galaxy, often only a few light-years away, and emit powerful GWs. It is now also known that binary stars are usually orbited by planets. This generates additional phase modulations (PM), which can also be detected.

2 Phase Modulation and Modulation Index

Technically speaking, the signals have an average frequency f_{Signal} and occupy a certain bandwidth from $f_{Signal} - \Delta f$ to $f_{Signal} + \Delta f$ because they are phase-modulated with

multiple frequencies f_{Mod1}, f_{Mod2}, f_{Mod3},... Known methods exist for recovering the modulation frequencies (demodulation). The results are presented individually in [2] to [18] and show the following common features:

- The average signal frequency f_{Signal} increases slightly over the entire 20-year measurement period. This is probably due to the loss of rotational energy due to the radiation energy of the binary star system.

- The frequencies of the PM are constant and consist of several discrete values. The presumed cause is planets orbiting the binary star systems.

- The modulation index η of each modulation frequency is invariably larger than the formulas of special relativity allow. The physical consequences are the core topic of this paper.

A sinusoidal PM causes the instantaneous frequency of the signal to oscillate periodically between the limits $f_{Signal} + \Delta f$ (maximum blueshift) and $f_{Signal} - \Delta f$ (maximum redshift). Δf is called the *frequency deviation*. The instantaneous frequency is never constant over time and is therefore usually difficult and imprecise to measure. This becomes increasingly difficult as the signal-to-noise ratio decreases. It is easier to determine the modulation index η (using the MSH method) and to calculate $\Delta f = \eta \cdot f_{Modulation}$. The modulation index η is the most important parameter for all questions concerning phase modulation.

3 Measurement results

In many independent measurement series, the frequencies of the mysterious continuous signals were measured over a wide frequency range, and the modulations were decoded. The sensor sampling rate (60 seconds) determines the highest measurement frequency (the Nyquist frequency is 8 mHz). Since hardly any reliable measurement series exist for periods longer than 20 years, frequencies below 100 nHz cannot be reliably measured.

Each signal examined, from [2] to [18], is phase-modulated with T=365 days, which suggests sources outside the solar system. The frequency deviations of the signals reach their maximums on different days of the year, which suggests different directions. It is not difficult to measure the respective modulation indices η – however, the interpretation of the corresponding frequency deviation Δf is a physical challenge.

If the signal source or the receiver or both are moving, the received frequency changes depending on the speed (Doppler effect). If the signal propagates at the speed of light c, then the relativistic equation

$$\Delta f = f_{Signal} \cdot \left(\sqrt{\frac{c+v}{c-v}} - 1 \right) \tag{1}$$

applies, where v is the relative velocity between the source and Earth. The measurements show that all signals are sinusoidally phase-modulated with $P \approx 1$ year. Assuming that

the sources are far outside the solar system and in the plane of the ecliptic, the distance between the source and the Earth decreases and increases every six months. Then the speed of the observer varies between the extreme values $-30 \text{ km s}^{-1} < v_{orbit} < 30 \text{ km s}^{-1}$.

Thus, equation (1) yields values for Δf that are much smaller than the measured results. If one trusts the measured values, there is only one way out: the signal speed is much lower than the speed of light. And it is frequency-dependent. From equation (1) we get after a short transformation

$$\frac{v_{orbit}}{v_{Signal}} = 1 - \frac{f_{Signal}}{f_{Signal} + \Delta f} \qquad (2)$$

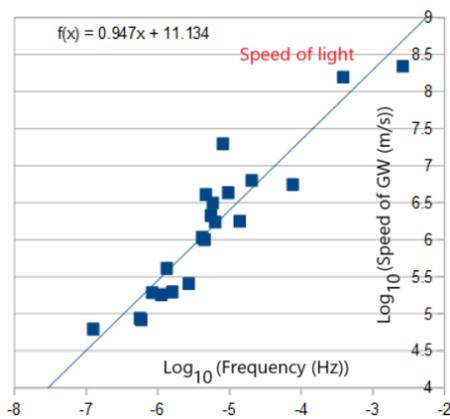Figure 1 shows the results for all individual measurements [2] to [18], which were calculated with equation (2).

Figure 1): *Propagation velocities v_{signal} of the mysterious waves as a function of frequency f_{signal}. All results are smaller than the speed of light, with the difference decreasing at high frequencies. The results from GW170817 may be added to the right outside the diagram at the level of the speed of light.*

The measured values are scattered due to the poor signal-to-noise ratio of the mysterious signals. However, at very low frequencies, it appears that there is a linear relationship between signal frequency and propagation velocity. In the range $100 \text{ nHz} < f_{signal} < 3$ mHz, the following would apply:

$$v_{Signal} \approx f_{Signal} \cdot 2 \times 10^{11} \text{ m} \qquad (3)$$

The significance of the proportionality factor 2×10^{11} m is unclear. It may be derived from fundamental constants and perhaps it only applies at a distance of 1.5×10^{11} m from the Sun. We do not know of any method to measure the propagation speed of GW at other distances from the Sun.

4 Discussion

If the measured oscillations are indeed generated by GW, Figure 1 shows that the propagation of GW is dispersive - meaning different velocities measured at different frequencies. This applies in the frequency range below 3 mHz and cannot be extrapolated to other frequency ranges without verification. This dispersion contradicts general relativity.

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The key questions remain: What causes the mysterious, continuous oscillations of the Earth and its atmosphere in the low frequency range? Many details suggest that the sources are nearby binary systems (with planets). Are these gravitational waves, as Einstein predicted, or new types of waves of unknown origin?

If it can be confirmed that these waves *are* GWs that do not propagate at the speed of light, this could provide the sought-after confirmation for gravitons with rest mass > 0. This, in turn, would imply that the range of gravity is not unlimited, as previously assumed. And then the postulated, but as yet undetectable, "dark energy" would be superfluous. This would change a lot in the world view of physics.

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