Light fields are also affected by gravitational waves!
Presenting strong evidence that LIGO did not detect gravitational waves in the GW150914 event

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Abstract

According to General Relativity, a passing gravitational wave can "shrink" objects and change their lengths. On this basis, the Laser Interferometer Gravitational-Wave Observatory's (LIGO) designers used a modified Michelson interferometer, thinking that gravitational waves could be recorded by using laser beam interference to observe the interferometer's arm variations.

However, LIGO's detectors have a basic problem: Light fields are also affected by passing gravitational waves.

When one gravitational wave "hits" LIGO's interferometers, it does not only "shrink" the interferometer's arms, but in fact, distorts its own space-time fabric, also "shrinking" the light beams. This means that no phase difference can be observed in the output of Michelson's interferometer, thus, gravitational waves cannot be recorded using this kind of equipment.

Considering this problem, this author believes that LIGO's detectors are not able to detect gravitational waves. However, after more than a decade in operation, without showing any results, in February 2016 the LIGO team announced the first detection of a gravitational wave in the GW150914 event, supposedly to be related to the collision of two black holes.

Despite the fact that more than 400 physicists say that LIGO's detection is true, for this author, Einstein's equivalence principle presents a barrier for the operation of LIGO's system, therefore, preventing it from detecting gravitational waves.

This author has accessed the data from the GW150914 event and, by playing "devil's advocate", has gone beyond the LIGO team's basic analysis.

The results of the analysis, presented in this article, point to the fact that the signals recorded by LIGO at the GW150914 event, cannot originate from the collision of two black holes, instead probably being the result of random noise sources picked up by the detectors.

Indexing terms/Keywords

Gravitational wave detection, LIGO, Laser Interferometer Gravitational-Wave Observatory

Academic Discipline and Sub-Disciplines

Relativity and Cosmology

SUBJECT CLASSIFICATION

Physics Classification

TYPE (METHOD/APPROACH)

Theoretical Analysis of LIGO's GW150914 event and articles explaining it. Processing the data recorded by LIGO's detectors in the GW150914 event, using Python programs provided by the LIGO team and a new whitening filter, developed by this author.

INTRODUCTION

According to General Relativity a gravitational wave affects space-time, changing "time flow" and "shrinking space".

Usually, gravitational wave detection experiments are designed to measure the shrinking of space using some variations of Michelson's interferometer.

Today, the most advanced of this kind of detector is the Laser Interferometer Gravitational-Wave Observatory (LIGO), which comprises two interferometers located in Hanford, Washington, and Livingston, Louisiana.

The basic LIGO operation is summarized in [1], with the following explanation:

"The LIGO sites each operate a single Advanced LIGO detector, a modified Michelson interferometer (see Fig. 1) that measures gravitational-wave strain as a difference in length of its orthogonal arms. Each arm is formed by two mirrors, acting as test masses, separated by $L_x = L_y = L = 4$ km. A passing gravitational wave effectively alters the arm lengths such that the measured difference is $\Delta L = \delta L_x - \delta L_y = h(t)L$, where h is the gravitational-wave strain amplitude projected onto the detector. This differential length variation alters the phase difference between the two light fields returning to the beam splitter, transmitting an optical signal proportional to the gravitational-wave strain to the output photodetector."

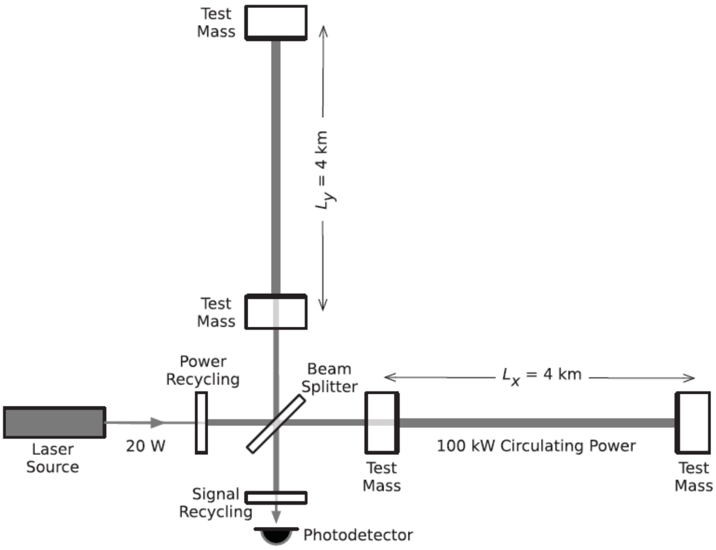

Fig 1: The LIGO detector: A modified Michelson interferometer.

From the statement above, the affirmation that "differential length variation alters the phase difference between the two light fields" is only valid if we consider that these light fields are not affected by gravitational waves.
However, General Relativity clearly shows us that light is affected by gravity, so the laser beams in the interferometer's arms are also affected by the gravitational wave that hits the detector.
This point can be better observed in Figure 2, where three different cases are shown.
In Figure 2-a, no gravitational waves are present, so the arm lengths and light fields are not affected, thus, no phase difference can be found in the photodetector's output.
When a gravitational wave passes through the detector, two different forms of behavior can be considered:
Figure 2-b presents a case where the arm length is affected by the gravitational wave (in this example, only the arm in the direction of the wave "shrinks") and where the light fields are also affected. Hence, no phase difference can be found in the photodetector's output, so no gravitational wave signal can be detected.
Figure 2-c presents a case where the arm length is affected by the gravitational wave, but the light fields are not. Therefore, a phase difference can be found in the photodetector's output that registers a signal, proportional to the gravitational wave's intensity.

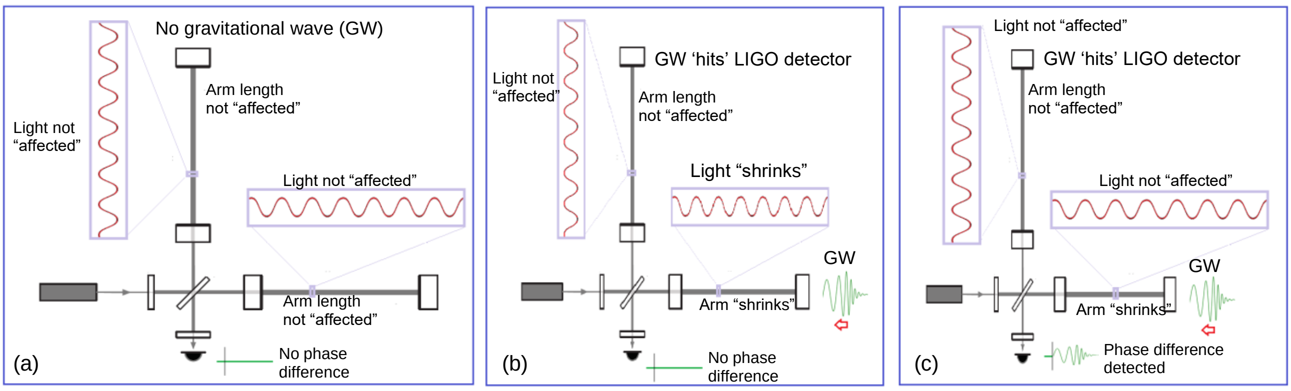

Fig 2: Three LIGO detector cases: a) No gravitational wave "hits" the detector.
b) Gravitational wave "shrinks" the arm length and "shrinks" the light fields (no phase difference).
c) Gravitational wave "shrinks" the arm length and light is not affected (phase difference detected).

When, in 1915, Albert Einstein developed General Relativity, he stated the equivalence principle:"There is no experiment a person can conduct in a small volume of space that would distinguish between a gravitational field and an equivalent uniform acceleration". So, if a horizontal light beam crosses a uniform accelerated volume, the person inside it will see that the beam follows a curved downward path, meaning that light should also follow the same path in a gravitational field.
The first confirmation of Einstein's prediction (that light is affected by gravitational fields) was made by Eddington's famous expedition, which observed the deflection of a star's light by the Sun's gravity, in the solar eclipse of May 29th, 1919.

A hundred years before, there was countless evidence that light can be affected by gravitational fields, such as, for example, the gravitational lens presented in Figure 3. Thus, making it hard to believe that there are physicists today who think that light fields are not affected by gravitational waves.

Fig 3: A giant gravitational lens: The view of a distant galaxy (nearly 10 billion light years away) has been warped into a near 90 degree arc of light by the gravity of the galaxy cluster known as RCS2 032727-132623 (which is about 5 billion light years away). Credit: NASA, ESA, J. Rigby (NASA GSFC).

Knowing that gravity affects light, it is obvious that when a passing gravitational wave effectively alters the Michelson interferometer's arm length, it also affects the laser inside the arm, and as presented in Figure 2-b, no phase difference between the two light fields can be detected.

This means that the LIGO system has a basic problem and is unable to detect gravitational waves.

However, in February 2016, the world received the news [1] that LIGO had finally detected a gravitational wave and recorded the GW150914 gravitational wave signal, shown in Figure 4.

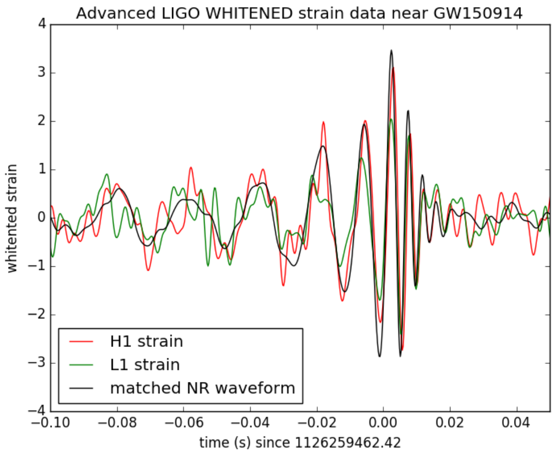

Fig 4: Processed signals from LIGO's GW150914 event

For this author, the first LIGO detection can be seen in two ways:

a) Either the laser beams in the LIGO detectors are, in fact, not affected (or minimally affected) by gravitational waves, something that should be studied further and clarified by the LIGO team;
b) Or actually, that LIGO did not detect any gravitational waves at the GW150914 event. Meaning that the curves presented in Figure 4 are only a result of random noise.

Despite more than 400 physicists saying that option (a) is true, for this author Einstein's equivalence principle presents a barrier for LIGO's operation, and so option (b) must be true.

Intending to prove the above statement, this author accessed and analyzed the data from the GW150914 event, and by playing devil's advocate, has gone beyond the basic analysis developed by the LIGO team.

In the next section, some new simulations and analyses are presented, pointing out the fact that LIGO probably detected only noise signals at the GW150914 event, which have no connection with gravitational waves generated from a black hole collision.

GW150914 EVENT's PRESENTATION

The curves in Figure 4 were plotted by this author, using the data provided by the LIGO team, in the tutorial "SIGNAL PROCESSING WITH GW150914's OPEN DATA" [2]. This figure shows the signals "H1 strain" and "L1 strain", which are a result of the signal possessing of LIGO's data recording at the GW150914 event, from the detectors in Hanford and Livingston.

Figure 5 presents the numerical relativity (NR) signal, which the LIGO team [3] calculated as a gravitational waveform, generated by the GW150914 event (connected to a black hole collision).

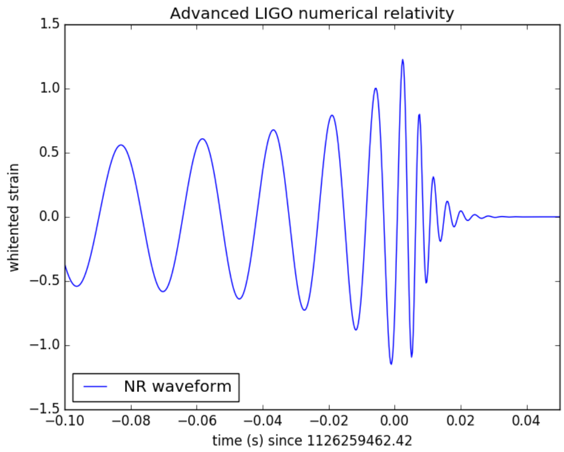

Fig 5: Numerical relativity signal: Gravitational waveform from the reported black hole collision.

To understand the signal processing that generated Figure 4's curves, we need to look at the biggest (known) limitation of LIGO: The detector is affected by many noise sources, as presented in Figure 6, which result in a very narrow measuring range, from 80 to 300 Hz.

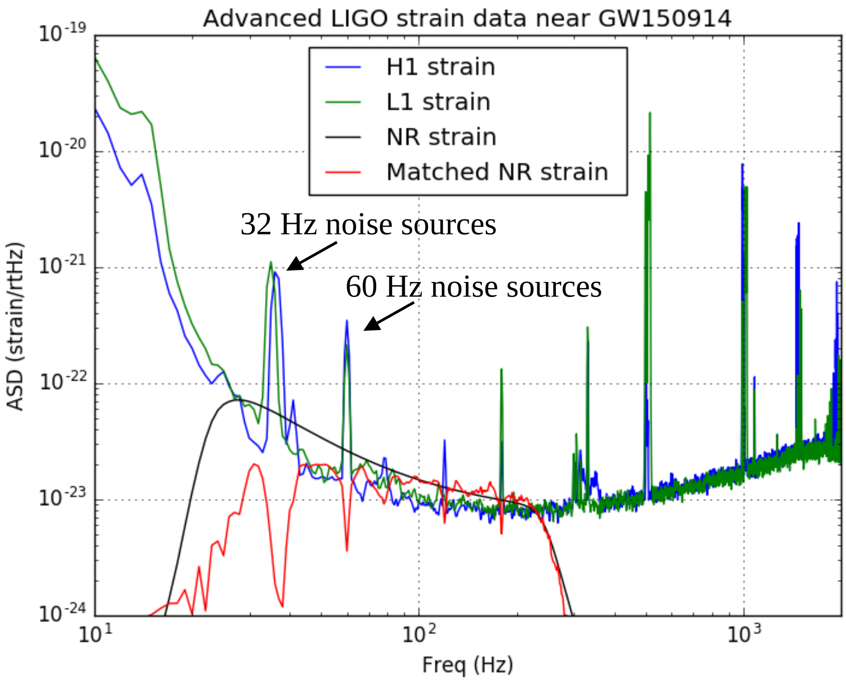

Fig 6: Frequency power spectrum of signals from LIGO's GW150914 event.

In fact, the power spectrum of the noise in each LIGO detector's output is a hundred times stronger than the desired gravitational wave signal. To remove all this noise, a "whitening" filter [5] technique can be applied to "clean" the data, suppressing the noise at low frequencies and the spectral lines. Thus, the whitening filter allows us to see the weak signals more clearly. In simpler terms, we can say that this filter eliminates signals that are repetitive (periodical signals), leaving only signals that have a short duration (non repetitive signals).
The problem with this whitening process is that the NR signal, presented in Figure 5, has some periodicity that is also removed by the filter.
Hence, as presented in Figure 7, when the NR signal (in green) is subjected to the whitening filter, it becomes the "matched NR" signal (in red), which only has 0.1 seconds of duration. This means that the event of the black hole collision generated a detectable gravitational wave with a few seconds of duration, but in LIGO's records we can only see the last 0.1 seconds of this event.
If LIGO had a larger measuring range (e.g. from 10 Hz to 300 Hz), the signal detected from the GW150914 event would have a much longer duration and there would be no doubt of it being a real gravitational wave. It would suffice to look at the gravitational wave signal (that would be similar to the green curve in Figure 7) seeing that, in fact, it comes from a collision of two black holes.

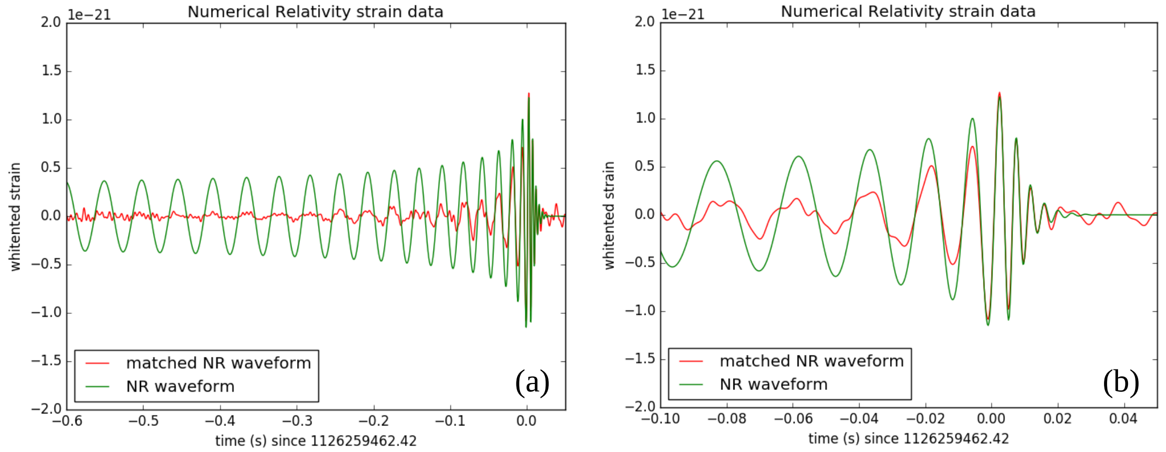

Fig 7: Numerical relativity signal (green) and matched NR signal (red): a) Signals at 0.6s time window; b) Same signals at 0.1s time window.

The LIGO detector's low range limitation generates a big problem, because the recorded gravitational wave can also be generated by some kind of noise signal, such as the red curve shown in Figure 8.
The H1 strain (the black curve in Figure 8) can be generated from a black hole collision (green curve) or by a possible spurious noise (red curve). Thus, only looking at LIGO's recorded strain signals does not make it possible to discern between a real event and a spurious noise event.

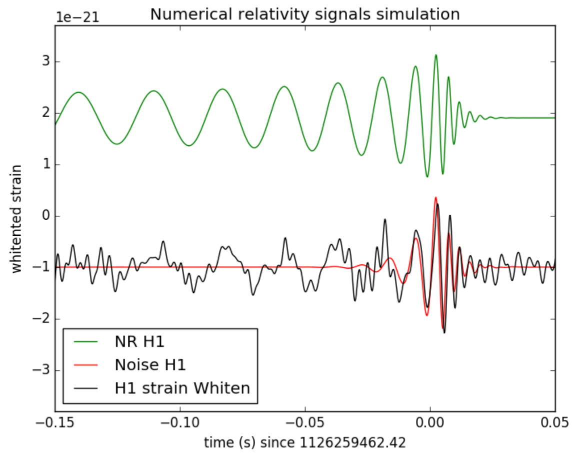

Fig 8: Two possible origins of the H1 strain signal (the strain at Hanford, in black) at the GW150914 event: The NR signal (in green) or a spurious noise signal (in red)

To be able to differentiate between the gravitational wave and the spurious noise, LIGO needed to use two detectors (Hanford and Livingston). In the GW150914 event, the same kind of waves were recorded from both detectors (see Figure

1), with a 7.5ms time window. As this time delay is inside a 10ms window (the maximum time that light takes to get from one detector to the other), this means that the signals detected at the GW150914 event can be gravitational waves.
But that does not eliminate the fact that the signals recorded in the GW150914 event could also just be two spurious noises that randomly hit the detector, and coincidentally, were in the same time window. Hence, the LIGO team presented a statistical analysis, calculating that this type of coincidence could occur once every 67,000 years, leading to the conclusion that they were the first to detect a gravitational wave.

The gravitational waves in the GW150914 event were detected by two different types of searches: The first search was to recover signals using optimal matched filtering, applying general relativity waveform predictions (generically NR signals). The second one targeted a broad range of generic transient signals (with minimal assumptions about waveforms) using whitening filter processing. These two kinds of search are analyzed in detail over the next sections.

ANALYZING WHITENING FILTER SEARCHING

The signals presented in Figure 4 were obtained from the data recorded by the LIGO detectors at Hanford and Livingston, by using a whitening filter [4]. This filtering process was implemented using Python language codes, which can be found in LIGO's tutorial [2]. This kind of whitening filter basically transforms periodic signals into white noise, so only the signals that are non-periodic, pass through the filter.
Thus, the main problem with the whitening filter process is that the gravitational wave, presented in Figure 5, has a periodic signal that is also removed by the whitening filter.

To better observe the efficiency of the whitening filter process, this author carried out the following test:

a) Got LIGO's data from a 32 second window, recorded after the time of the GW150914 event (for example, 20 seconds after), guaranteeing that there are no gravitational waves in this data;
b) Added the numerical relativity signal (presented in Figure 5) in the middle of this data. In Livingston's case, the NR signal was multiplied by -0.77 and shifted by 7ms. This became a very good simulation of a gravitational wave mixed with LIGO's typical noise sources;
c) Applied the whitening filter process to this simulated signal (the SIM signal), then observed the results, comparing them with to the results obtained from the GW150914 event.

Figure 9 shows the signals obtained from the whitening filter process using the real event data and the simulated event data. To better compare the results, the four curves presented in Figure 9 are overlapped in Figure 10. Thus, we can easily see that the results from processing the simulated data, are very similar to the results from processing the real data.

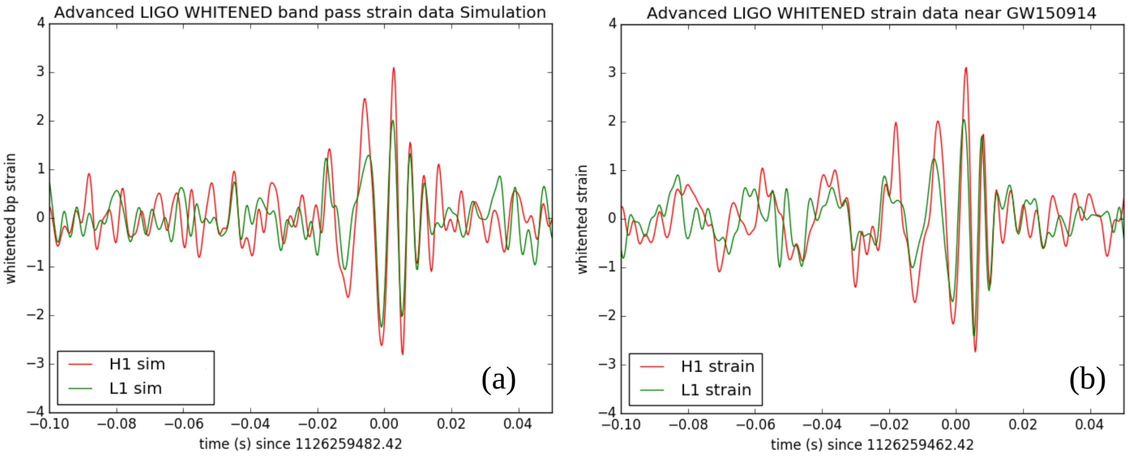

Fig 9: Signals processed by the whitening filter: a) Simulated signals; b) Real event signals.

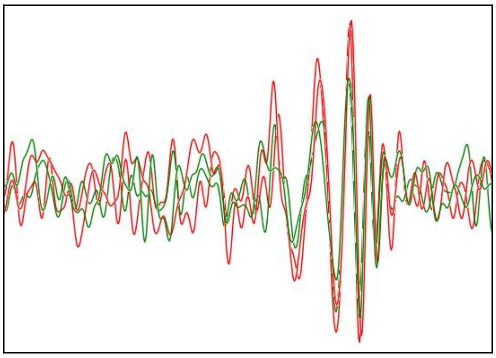

Fig 10: Four signals from Figure 9 overlapped in the same time window

The curves presented in Figures 9 and 10 give us a clear indication that:
If the NR signal, presented in Figure 5, hits the LIGO detector, the whitening filter process can remove all the superimposed noise and detect the gravitational waveform (NR signal), generating the curves shown in Figure 4.

However, this simulation makes it possible to explore a further aspect: multiplying the SIM signal by a constant factor, we can observe the dependence of the whitening filter's results from the NR signal's amplitude.
Figure 11 presents a case where the NR signal was divided by 3 and by 4, before being added to the data window.
Thus, if the gravitational wave had an amplitude 3 times lower, the Livingston LIGO detector would not be able to identify the gravitational wave, because the remaining noise is higher than the signal.
Moreover, if the gravitational wave had an amplitude 4 times lower, the Hanford LIGO detector would also not generate a recoverable signal.

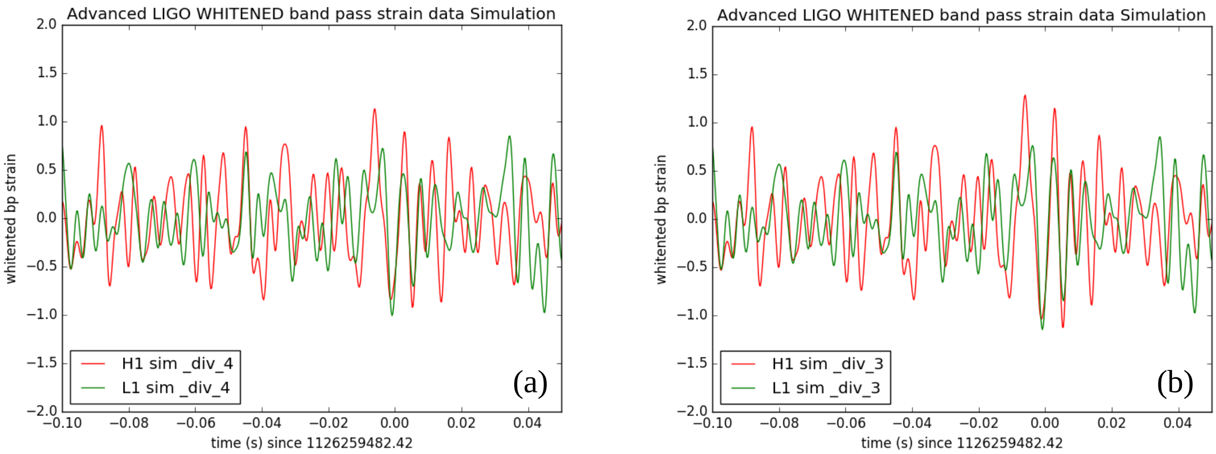

Fig 11: Results of the whitening filter process: a) Simulation using the NR signal divided by 4; b) Simulation using the NR signal divided by 3.

In Figure 11, the noise signals and the simulated gravitational wave signals become mixed and cannot be differentiated. This problem becomes more critical when looking at a large time data window.
From the above results, we can conclude that:

In the GW150914 event, the LIGO system operated close to its detection limits. If the gravitational wave signals had an amplitude 3 or 4 times smaller, its waveforms could not have been detected using the whitening filter process.

ANALYZING THE OPTIMAL MATCHED FILTERING SEARCHING

The optimal matched filtering [5] searches for gravitational waves using templates (waveforms) predicted by general relativity. It is important to note that this kind of search does not give results as a waveform like those given by the whitening filter, presented above. Thus, the optimal matched filtering only indicates if the tested waveforms are present in the recorded data, also giving its time position and Signal Noise Relation (SNR).

As we know the NR signal's waveform, we can use it as a template to test the optimal matched filtering in two cases, dealing with the real event and the simulated data presented above.

Figure 12 presents the results of the optimal matched filtering, implemented using the Python code [6] from the LIGO team. It's easy to see that the real event and the simulated event generate the same outputs, when the NR signal is used as a template.

This means that:

If the NR signal, presented in Figure 5, hits the LIGO detector, the optimal matched filtering can detect the signal's position giving an SNR close to 15 in the data recorded in Hanford and close to 10 in Livingston.

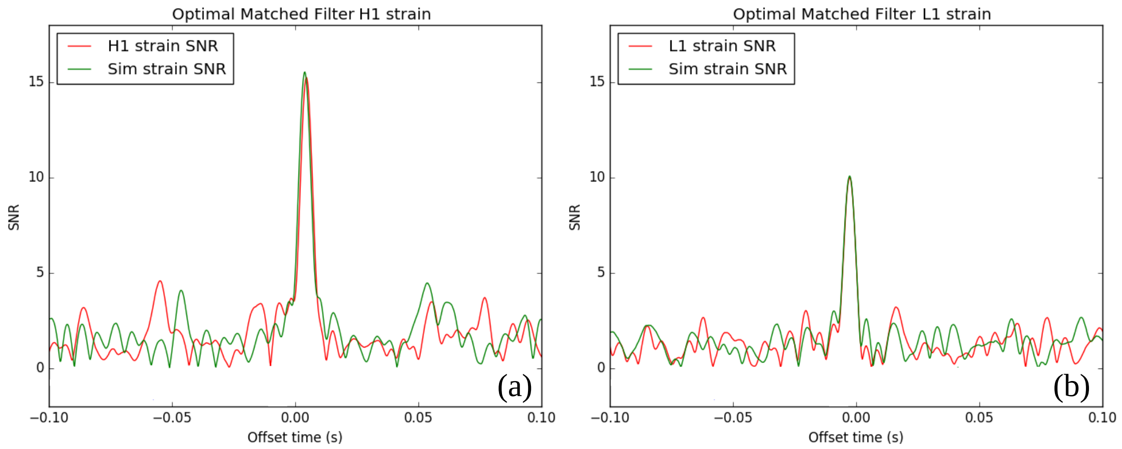

Fig 12: Results of optimal matched filtering. a) Hanford (H1) detector: real data (in red) and simulated signal (in green); b) Livingston (L1): real data (in red) and simulated signal (in green).

CUTTING THE SNAKE'S HEAD

The NR signal presented in Figure 5 represents the numerical results from some computer simulations of gravitational waves generated by the collision of two black holes. These simulations came from models based on the General Relativity theory.

The analysis presented above was based on the creation of two simulated signals (H1_sim and L1_sim), calculated by adding the NR signal to the centre of a typical 32 second data window from the detectors in Hanford and Livingston (for example, the data recorded 20 seconds after the GW150914 event).

The results from the application of the two searching methods, processing the simulated signals, can be observed in Figures 9, 10 and 11. It is easy to see that these results are very similar to those obtained using the real data recorded at the GW150914 event.

However, this author believes that these searching methods mainly found just a small part of the NR signal!

In a simple analogy: If the NR signal, which is hidden by noise, is compared to a snake hidden by grass, when searching for it (using two differing procedures), we can only find the snake's head (only the last 0.1 seconds of NR signal).

But what about the "snake's tail"?

If we cut the "snake's head", can its "tail" also be detected?

To answer this question, this author created a new template (optimal matched pattern NR-289), shown in Figure 13-a. This NR-289 signal is basically the same as the NR signal, but with its final 0.0727s (the final 289 values) set to zero.

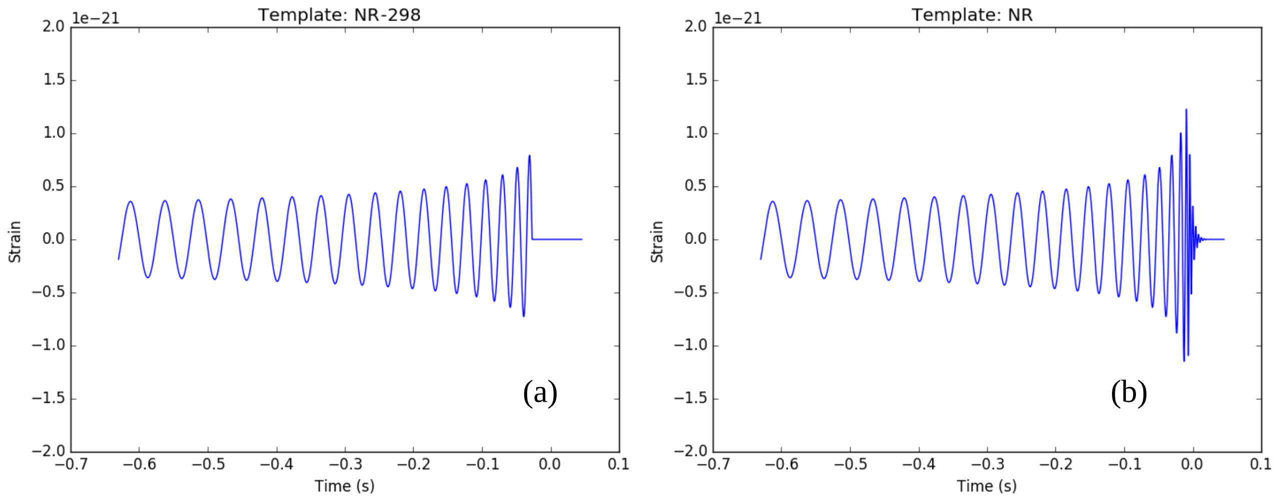

Fig 13: Two waveform templates: a) NR-298 - NR signal with the final 0.0727s (final 298 curve points) set to zero; b) Original NR signal.

The optimal matched filtering searching method is applied to the real signal and the simulated signal (the complete NR signal continues being used to generate this simulated signal) using the NR-289 signal as a template, giving the results presented in Figure 14.

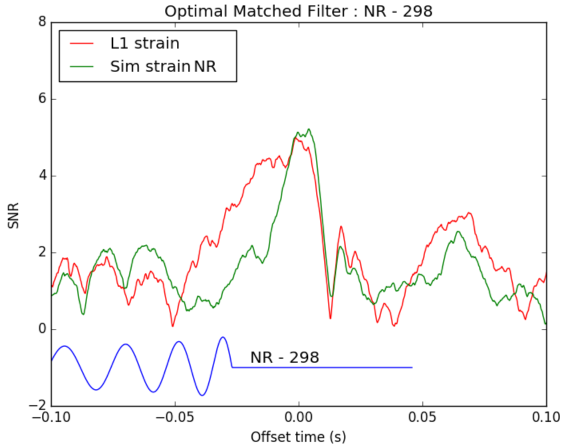

Fig 14: Optimal matched filtering results using the NR-298 signal (in blue) as a template, applied to process real data and simulated data (obtained by adding the NR signal to the recorded noise in Livingston). The red curve is the result of filtering the real data and the green curve is the result of filtering the simulated data.

In Figure 14, the blue curve represents the NR-289 signal (the snake's tail) and the red curve represents the matched Signal Noise Relation (SNR) for the real data (obtained from the GW150914 event in Livingston). The green curve represents the matched SNR for the simulated data (generated by adding the NR signal to the data recorded in Livingston, 20 seconds after the GW150914 event).

Observing the curves in Figure 14, this author believes that if the red curve and the green curve are the same, then the LIGO system has effectively detected a "complete snake".

But these curves are different!

Here comes the doubt: If in the previous results, presented in Figures 9 and 12, the real data and the simulated data generate virtually identical curves, then why is there a difference between the curves (red and green) in Figure 14?

In order to analyze if these differences come from changes in the background noise, the NR signal was multiplied by a constant value (gain) and added to several data windows. In all cases, the optimal matched filtering process (using the NR-289 signal as a template) generates the same output curves (the green curve in Figure 14), changing only the curves' amplitudes, depending on the gain applied.

Thus, the differences between the red curve and the green curve in Figure 14 are an obvious indication that the signal recorded in the GW150914 event in Livingston didn't contain a signal exactly equal to the NR signal.

Figure 15 presents the NR signal and a Simulated Noise (SN) signal, generated by this author using a 32 Hz sine wave, where a high-frequency noise was introduced during a half cycle. In this figure, It's easy to see that the NR signal (in red) and the SN signal (in blue) have the same high frequency "piece", but the blue curve is certainly nothing related to a gravitational wave that was generated from the collision of two black holes.

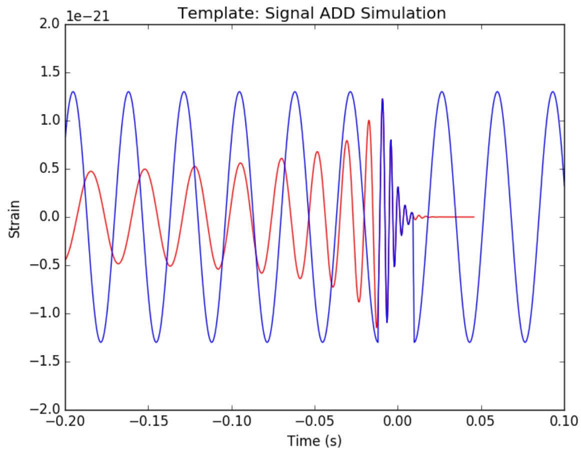

Fig 15: NR Signal (in red) and Simulated Noise (SN) signal (in blue).

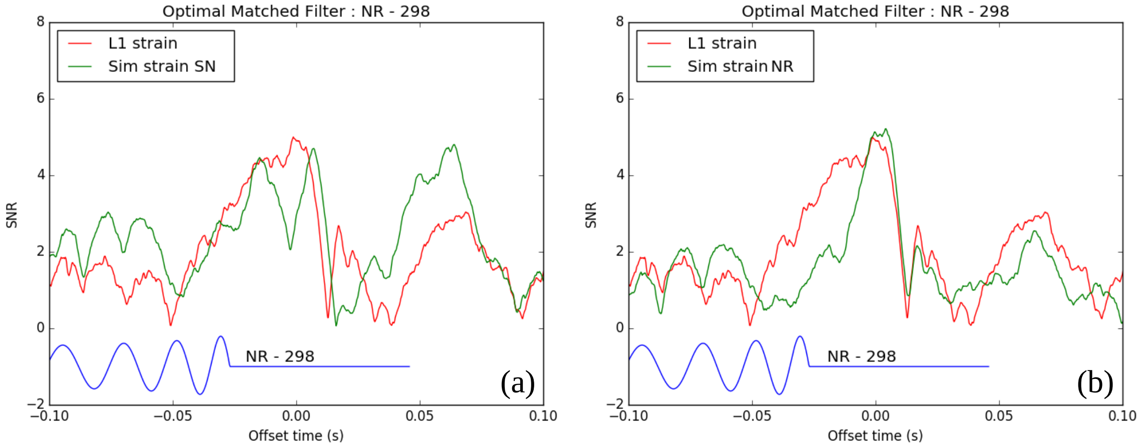

Fig 16: Optimal matched filtering (using the NR-298 signal in blue as a template) results: a) Processing the real data (L1 strain, in red) and the simulated data (in green) obtained by adding the SN signal to the noise recorded in Livingston; b) Processing the real data (L1 strain, in red) and the simulated data (in green) obtained by adding the NR signal to the noise recorded in Livingston

The SN signal presented in Figure 15 was added to the data recorded in Livingston, 20 seconds before the time of the GW150914 event, generating a new simulation signal. This signal was processed using the optimal matched filtering with the NR-298 signal used as a template.

Figure 16-a presents the optimal matched filtering results with the NR-298 signal as a template, obtained by processing this new simulation signal (with the SN signal added). To facilitate comparing the results, Figure 16-b presents the same curves shown in Figure 14.

In Figure 16-a, It is easy to observe that the shape of the curves (in red and green) are more similar to those in Figure 16-b. This means that the signal recorded from the GW150914 event in Livingston is more similar to the SN signal (the blue signal presented in Figure 15) than it is to the NR signal.

So, the curves in Figure 16 provide the first piece of evidence that the LIGO detector probably didn't detect a real gravitational wave.

ULIANOV WHITENING WITH NOISE BAND-PASS FILTER

Considering that the signal detected by LIGO has a relationship with the Simulated Noise signal presented in Figure 15 (in blue), we can observe that this SN signal is basically a sine wave of 32 Hz.

If we observe the power spectrum of the LIGO detectors, presented in Figure 6, it is possible to note a large noise source in the 32 Hz range.

Thus, to better study this noise source, this author created a new type of whitening filter that allows the "passing" of some noise sources, in a given range, configurable by means of two frequency values.

This new filter was named by this author as the Ulianov Whitening Filter with Noise Band-Pass (UWF-NBP). The Python source code of the UWF-NBP is presented in annex 1.

The UWF-NBP works on the same basis as the "standard" whitening filter, but some noise sources (in a given band pass range) are not whitened. This allows some specific noise to appear together with the signal from the filter output.

In Figure 17, the blue curve represents a gain that the standard whitening filter procedure defines at each frequency, causing the whitening process. The red curve represents the gain of the UWF-NBP, which is the same as the blue curve, except between the range of 31.5 to 43.5 Hz, where the noise is multiplied by a large value (red line).

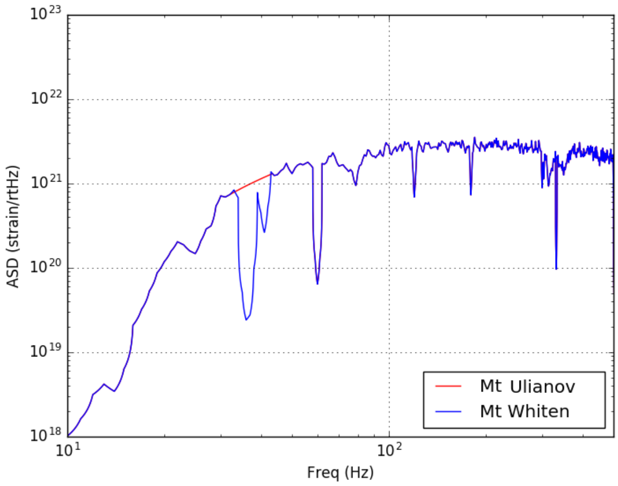

Fig 17: Gain curves used in the “standard” whitening filter (in blue) and in the UWF-NBP (in red), from a range of 31.5 to 43.5Hz

The curves in Figure 17 mean that the whitening filter “deleted” the noise between 31.5 to 43.5 Hz and the UWF-NBP allowed this noise to appear in the filter output. This behavior can be seen in the curves in Figure 18, where the green one presents the output of the whitening filter and the red one presents the output of the UWF-NBP. Where the 32 Hz noise can be easily observed in the red curve and is not present in the green one.

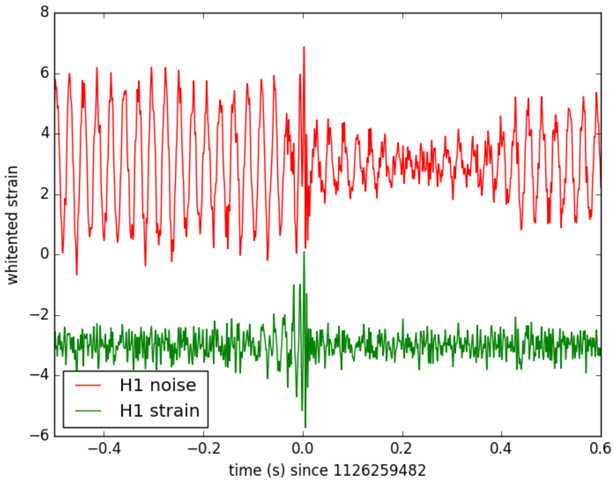

Fig 18: Curves obtained processing the real data (H1 strain) with the standard whitening filter (in green) and the UWF-NBP (in red), from 31.5 to 43.5Hz

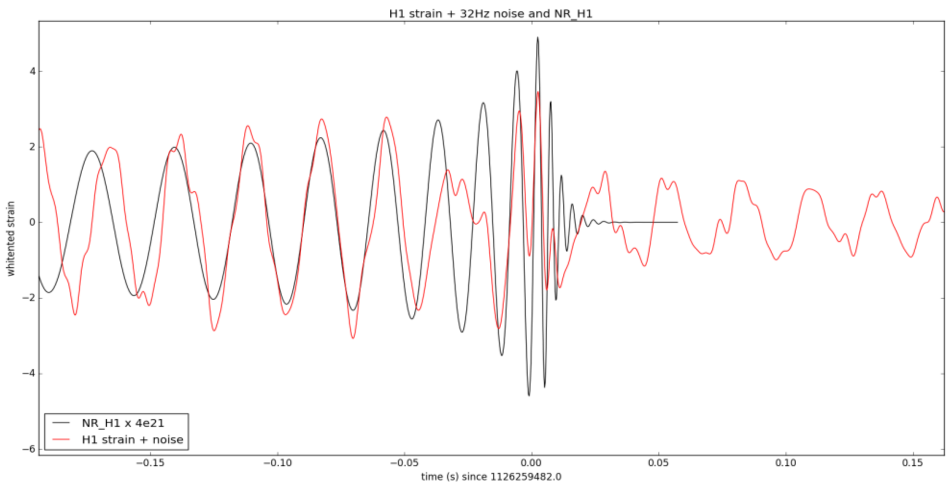

Fig 19: Curve of the NR signal (multiplied by $4x10^{21}$) and 32 Hz noise signal, obtained by processing the real data with the UWF-NBP, from 31.5 to 43.5Hz

Allowing the noise in the 32 Hz range to be "released" from the filter output creates some new ways to analyze the GW150914 event:

- In Figure 19, the signal from Hanford (H1 strain) added with the 32 Hz noise, is compared with the NR signal. Note that the NR signal needs to be multiplied by a factor of $4x10^{21}$ to keep to the same scale, because the whitening filter multiplies the input signal for a gain near to 10^{21}, as presented in Figure 17. From observing the curves in Figure 19, we can see that in a time window of -0.15s to -0.5s, the NR signal is very similar to the 32 Hz noise. This fact leads us to question: Why is the NR signal, which is generated from the collision of two black holes, so similar to the 32 Hz noise (that comes from LIGO detector)? Also, why are these two signals exactly synchronized in time?
- In Figure 20, the 32 Hz noise level is observed using two black lines near the signal's peaks. It is easy to see that before the GW150914 event (at zero time in Figure 20) the 32 Hz noise has a higher level and after, the noise level decreases. This fact leads us to question: How can a "gravitational wave" that hits the detector affect the 32 Hz noise level?

The questions above point to a type of relationship between the NR signal and the 32 Hz noise, which, together with the previous results (presented in Figures 15 and 16), generate strong doubts as to whether LIGO have actually detected a gravitational wave in the GW150914 event.

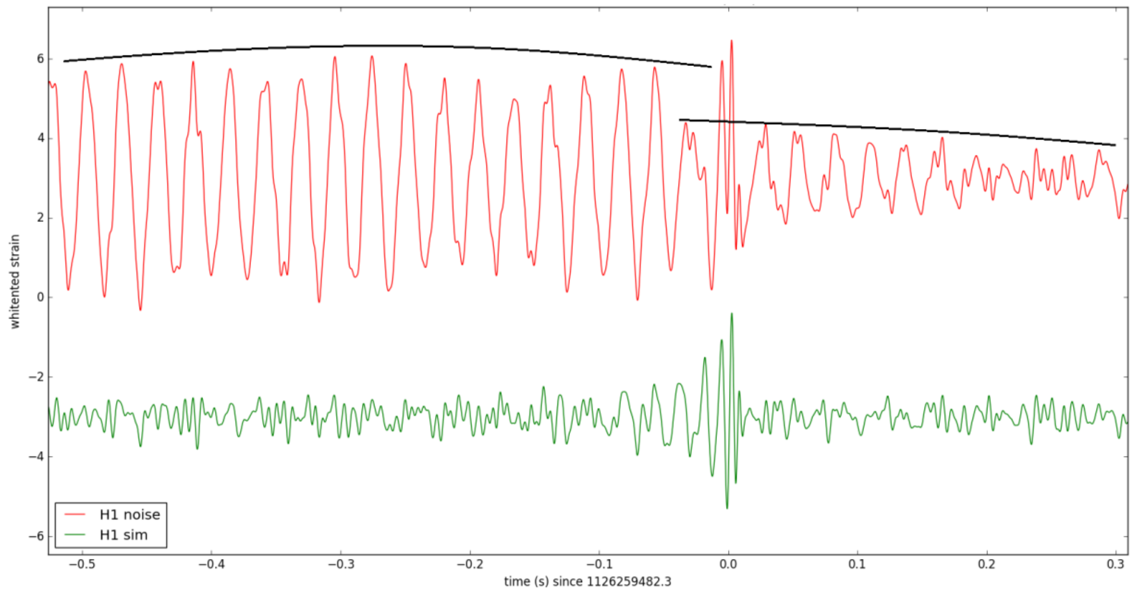

Fig 20: Same curves from Figure 15 in a larger scale. The red signal is basically a 32 Hz noise and the two black lines represent the level of this noise after and before the time of the GW150914 event

ANALYSIS OF THE 60Hz NOISE

Figure 21 presents another application of the Ulianov Whitening Filter with Noise Band-Pass, allowing the 60Hz noise to be observed from the filter output.

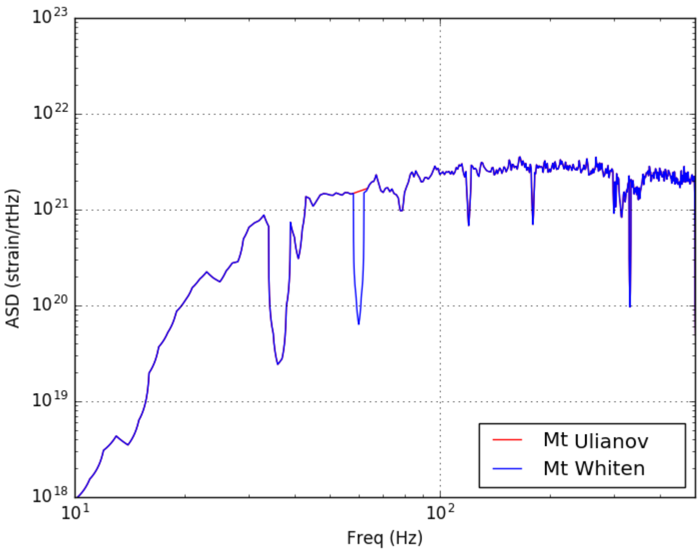

Fig 21: Gain curves used in the whitening filter (in blue) and the UWF-NBP, from 57.5 to 63.5 Hz (in red)

The data recorded in the GW150914 event in Hanford (H1) and Livingston (L1), was processed with the UWF-NBP, releasing noises from 57.5 to 63.5 Hz. The results are presented in Figure 22, where the strain data is overlapped with a 60Hz noise.

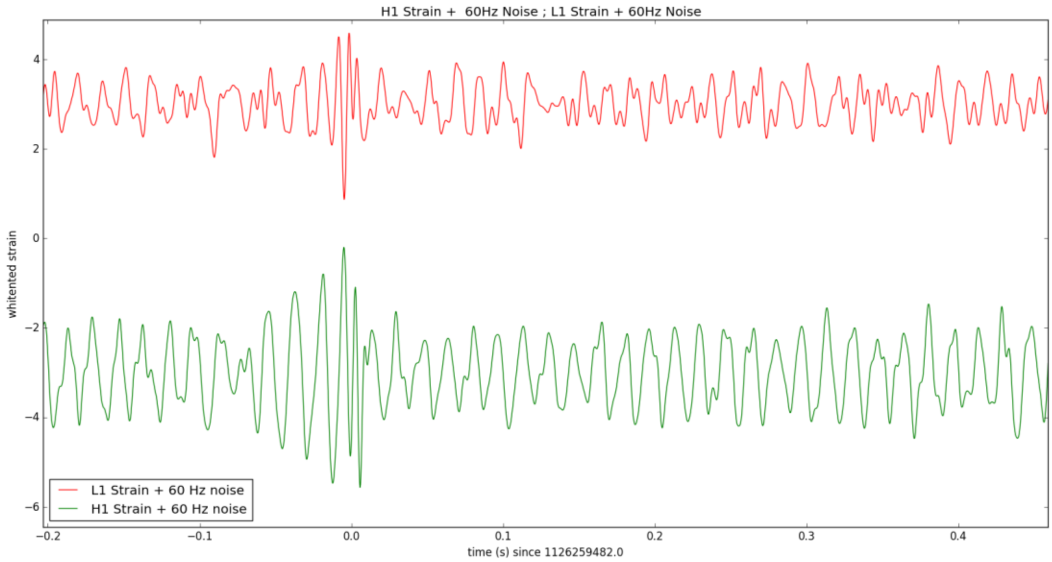

Fig 22: Curves obtained by processing the real data with the UWF-NBP (from 57.5 to 63.5 Hz), resulting in a 60Hz noise added to the L1 and H1 strain signals

The curves in Figure 22 have a noise signal in the 60Hz range that was released by UWF-NBP. If these curves overlap (shifting the Livingston signal to 11ms), it is possible to observe that both the 60Hz signals become in phase, as can be seen in Figure 23. The curve points in the blue circles in Figure 23 indicate that the two 60Hz signals are in phase.

By a rare coincidence, when we put the 60Hz noises in phase, the initial higher frequency peaks (associated with gravitational waves), as indicated by two blue arrows in Figure 23, also overlap. Note that the Livingston signal is not inverted in this figure.

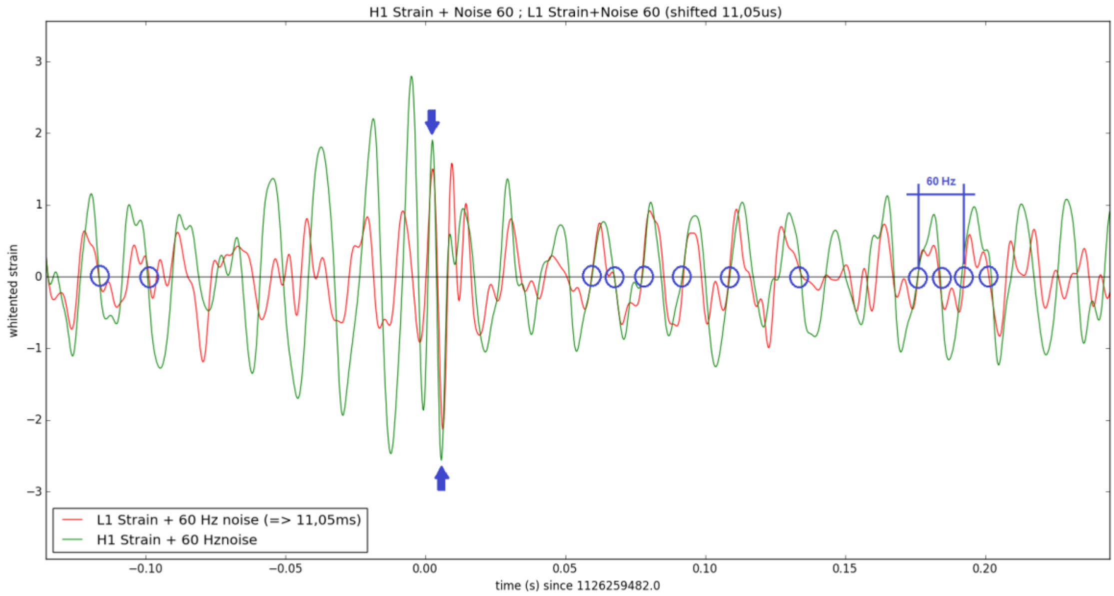

Fig 23: Same curves from Figure 19 with the L1 strain curve (not inverted) shifted to 11,05ms. The blue circles represent some points where the 60Hz noise signals have the same phase.

The curves in Figure 23 bring about a new question: Why do the two main peaks (of the gravitational waves recorded from both detectors) become perfectly synchronized (as indicated by the blue arrows in Figure 23) when the 60Hz noises in the detectors are also synchronized?

PROBABLE ORIGINS OF SIGNALS IN LIGO'S GW150914 EVENT

By analyzing the noise spectrums in LIGO's detectors (as presented in Figure 6), we can suppose that the large noise source at 32 Hz is connected to the 60 Hz electrical power noise source. This means that a sub-harmonic of the 60 Hz noise (at 30Hz) maybe "hits" some mechanical system with an oscillation frequency close to 32 Hz. In this case, a difference of 2 Hz exists between these frequencies, so the 32 Hz noise will tend to be modulated by a 2 Hz signal.

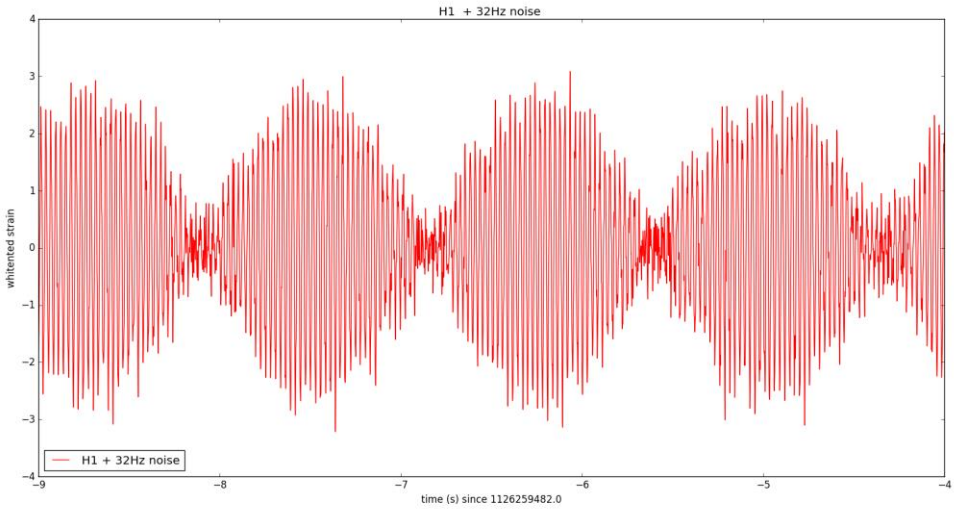

Fig 24: 32 Hz Noise of detector in Hanford modulated by a lower frequency signal in the range of 2.5 Hz

As presented in Figure 24, if we look at the 32 Hz noise in a large time window, a 2.5 Hz modulation signal is easily observed. This means there is a 32.5 Hz resonant system noise source that is powered by the 30 Hz sub-harmonic (from the 60 Hz electrical power), resulting in a 2.5 Hz modulation.

This author does not know the background details of the electric power interconnection between LIGO's detectors in Hanford and Livingston. However, the curves in Figure 23 seem to point to a possible link between a "power phenomenon" (that occurred in the 60 Hz power system) and the signals detected in LIGO's GW150914 event.

This “power phenomenon” could be something very subtle, such as a change in frequency in the electrical system due to some instability in generation. For example, a variation from 60.1 Hz to 59.9 Hz (maintaining the voltage at a constant level) perhaps did not appear on LIGO’s electric power monitoring system.
However, for a system that oscillates at 32.5 Hz, a small change in the 60 Hz power source (for example 0.2 Hz) means a broad modulation frequency variation (for example from 2.5 Hz to 2.3 Hz). This modulation change results in a time difference of 0.032s, which as we can see in Figure 7, is close to the duration of the gravitational waves recorded in the GW150914 event.

As the two LIGO detectors were constructed in the same way, we can suppose that the 32.5 Hz noise sources in Hanford and Livingston both have the same behavior. In fact, we can see these noise sources in both detectors in the power spectrum graph, presented in Figure 6, including the 60Hz noise source.

As these 32.5 Hz noise sources are powered by the 60 Hz noise, modulated by a low frequency (2.5 Hz = 32.5 Hz – 30.0 Hz), an abrupt 60 Hz frequency variation can “hit” the 32.5 Hz oscillation system. Thus, the 32.5 Hz noise changes over time (as shown by the red curve in Figure 20) and may go through a period of oscillation in a higher frequency, which was considered as a gravitational wave signal by the LIGO team. This hypothesis also explains why the estimated NR signal is so similar to the 32 Hz noise source, as presented in Figure 19.

THE BASIC PROBLEM WITH LIGO’S DETECTORS

The analysis presented above, seems to show that the LIGO system has probably detected only noise in the GW150914 event. Evidently, it needs to be better evaluated, but there is something much bigger to be discussed here:

For this author, LIGO’s detectors, in their present configuration, are not able to record gravitational waves.

From Special Relativity, we know that a spaceship traveling in space at high speed becomes shorter in its moving direction. Considering that Earth moves at, at least 360 km/s (in relation to the CBM), we can try an experiment to test its shrinkage, which varies according to its rotation.

The LIGO team intend to detect gravitational waves using light beams to record the interferometer’s arm length variation (through the waves hitting the detectors), expecting to observe phase differences between the light fields inside the interferometer’s arms, thinking that light is not affected by gravitational waves.

Using an analogy, it is like carrying out an experiment using light beams to record the interferometer’s arm shrinkage (through Earth’s movement/rotation), expecting to observe phase differences between the light fields inside the interferometer’s arms, thinking that light is not affected by Earth’s movement/rotation as the speed of light is constant.

In fact, this experiment (known as the famous Michelson–Morley experiment) detected nothing!
The Michelson interferometer completely fails to record phase differences between the light fields inside the interferometer’s arms, whether caused by variations in the speed of light or shrinkage of Earth itself.

The Michelson interferometer is a failure because both phenomena, which change the interferometer’s arm lengths (as predicted by Special Relativity and General Relativity), can also change the behavior of light. Thus, nothing can be detected, providing a relativistic point of view for all considered observers.

Just over a hundred years ago, Albert Michelson, after 12 years of trying to make the experiment work, had the courage to admit that the experiment had failed!

Now LIGO’s designers are trying to use a modified Michelson interferometer to do the same thing: detect arm length variations caused by gravitational waves, thinking that light is not affected by gravitational waves.

So, the LIGO detectors are based on an experiment that became famous for having failed!

After spending 14 years trying to make the LIGO system work, those responsible for this experiment, improved it by increasing the detectors accuracy, arriving at a point where the noise was greater than the expected signal. And so, they eventually got two synchronized noises that look like true gravitational wave signals.

In his book [7], German Physicist Alexander Unzicker, makes a critique of the incremental improvement of modern scientific experiments:

> *To extract signals, technology has to be pushed to the limits, but this is anything but a scientific revolution...Indeed physics, after the groundbreaking findings at the beginning of the twentieth century, has undergone a paradigmatic change that has turned it into another science, or better, a high-tech sport, that has little to do with the laws of Nature.*

CONCLUSION

Despite all the excitement of the LIGO team, the analysis presented above, clearly points to the fact that only noise was detected by LIGO in the GW150914 event.
Furthermore, there is a serious problem in the design of LIGO's detectors. Based on Michelson's interferometer, a historically flawed experiment, the current configuration of these detectors is unable to detect any gravitational waves due to one small factor:

Light fields are also affected by gravitational waves!

The LIGO system does not work because of the gravitational waves distorting (stretching and shrinking) space time in an unusual way. Hence, in one easy analogy, it is like the interferometer's arms and the laser beams inside them are painted on a rubber sheet. When the sheet is stretched, the arms and the light beams are also stretched, so no light phase changes may be observed.

This author hopes that those responsible at LIGO are open-minded enough to follow the example of Albert A. Michelson. After 12 years of improving upon his experiment, without obtaining any results, Michelson had the courage to admit that the experiment had failed, possibly due to a theoretical problem.

Michelson's experiment only set out to confirm that the Newtonian model was right, where the speed of light changes, depending on the direction of "Ether wind". As the experiment failed, it actually opened the door to Einstein's Special Relativity theory, something far more important than confirming an old theoretical model.

However, it must not be forgotten, that until today, Michelson has been the only physicist to win a Nobel Prize for carrying out an experiment that completely failed!

So, there is a great opportunity here. The fact that LIGO's experiment did not work, because of a theoretical problem, perhaps puts it side by side with the Michelson–Morley experiment.

Today all physicists believe in Einstein's proposition that "matter shrinks space".
However, this author proposes an alternative way to interpret General Relativity's field equations [8], where in fact "matter expands space". This means that Planck distance and Planck time expand due to the presence of gravitational fields, including those generated by the gravitational waves that LIGO wish to detect.

This new model has the potential to become a bridge to linking Quantum Mechanics with General Relativity and generate a new way to detect gravitational waves, using a "time interferometer", based on the Witte effect [9], which can detect "time flow" variations that appear when gravitational waves hit the detector. This new equipment is named by this author as the Witte-Ulianov Time Interferometer (WUTI) [10].

The WUTI gravitational-wave detector achieves "time flow" variations, therefore is not susceptible to vibration or electromagnetic problems. The main source of noise in the WUTI's measuring system is caused by Earth's rotation, due to the WUTI detector being susceptible to the expansion/shrinking process that occurs as the planet travels in space following the movements of the solar system and the Milky Way.

In conclusion, the good news for the LIGO team is that there is a way of actually measuring gravitational waves, by using the WUTI detector, which is able to detect time dilatations caused by gravitational waves without any low frequency limitation. This new equipment is inexpensive and can be easily installed in a short time, improving on LIGO's existing structures. The Witte-Ulianov Time Interferometer, not only allows the observation of low frequency gravitational-waves, but is also very likely to be capable of observing the gravity ocean surrounding Earth.

Even though the LIGO team has not detected a real gravitational wave, they must be congratulated for the transparency and availability of all the information provided (related to the GW150914 event), which has allowed the analysis presented in this article.

ACKNOWLEDGMENTS

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ABOUT THE AUTHOR

Policarpo Yōshin Ulianov is an electrical engineer with a Master's degree in Electronic Speckle Holography and a Doctorate degree in the field of Artificial Intelligence. He studies theoretical physics as a hobby and, from over 20 years of research, has brought together a series of interesting ideas, resulting in the development of some new models [11] [12] [13], including a new cosmological model named the "Small Bang" [14]. This author has interest in partnerships with research centers, companies and universities to spreading and improve the work that he is developing.

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ANNEX 1 – PYTHON CODE:
ULIANOV WHITENING WITH NOISE BAND-PASS FILTER

```
'''#############################################
Ulianov Whitening with Noise Band-Pass Filter
File name: ulianov_whiten.py
Date: 29/02/2016
Created by: Policarpo Yoshin Ulianov

Input Parameters:
strain: Signal to whitening
interp_psd: PDS interpolation function
dt: Delta Frequency
FreqIni and FreqSup: Range of frequency to liberate noise (eg: 30.0 - 35.0)
plotgraf: if 1 plot graphics
DirSave: Directory to save graphics
nameSignal: Name of signal. eg: L1_NR_H1x2

Output: Whitening signal with band-pass noise add
#############################################'''

import numpy as np
import matplotlib.pyplot as plt

def ulianov_wnbp(strain, interp_psd, dt,FreqIni,FreqSup,plotgraf,DirSave,nameSignal):

  Nt = len(strain)
  freqs = np.fft.rfftfreq(Nt, dt)

  hf = np.fft.rfft(strain)
  factor_whiten = 1/(np.sqrt(interp_psd(freqs) /dt/2.)) #Standard whitening factor

  factor_noise = factor_whiten +0.0
  #Test all frequency range:
  init1=0
  init2=0
  for i in range(1,len(hf)):
    if (freqs[i]>FreqIni) and (freqs[i]<FreqSup):
      if init1==0:
        init1=i
      else:
        init2=i

  #Interpolate a line between FreqIni and FreqSup:
  tam=init2 - init1
  for i in range(0, tam):
       factor_noise [init1+i]=factor_whiten [init1]*(tam-i)/tam + factor_whiten [init2]*i/tam

  if plotgraf: #If need plot graphics:
    fmin = 10
    fmax = 500
    namearq=DirSave+'ASDs_UWNoise_'+nameSignal+'.png'
    graftitle ='ADS Ulianov Whitening with Noise Band-Pass: '+nameSignal
    plt.figure()
    plt.loglog(freqs, factor_noise,'r',label='Mt Noise free')
    plt.loglog(freqs, factor_whiten,'b',label='Mt Whiten')
    plt.axis([fmin, fmax, 1e18,1e23])
    plt.grid('on')
    plt.ylabel('ASD (strain/rtHz)')
    plt.xlabel('Freq (Hz)')
    plt.legend(loc='lower right')
    plt.title(graftitle)
    plt.savefig(namearq)
    plt.close()

  white_hf = hf * factor_noise
  white_ht = np.fft.irfft(white_hf, n=Nt)
  return white_ht
```