News

Detection of Gravitational Wave by LIGO 100 Years after Einstein's Prediction

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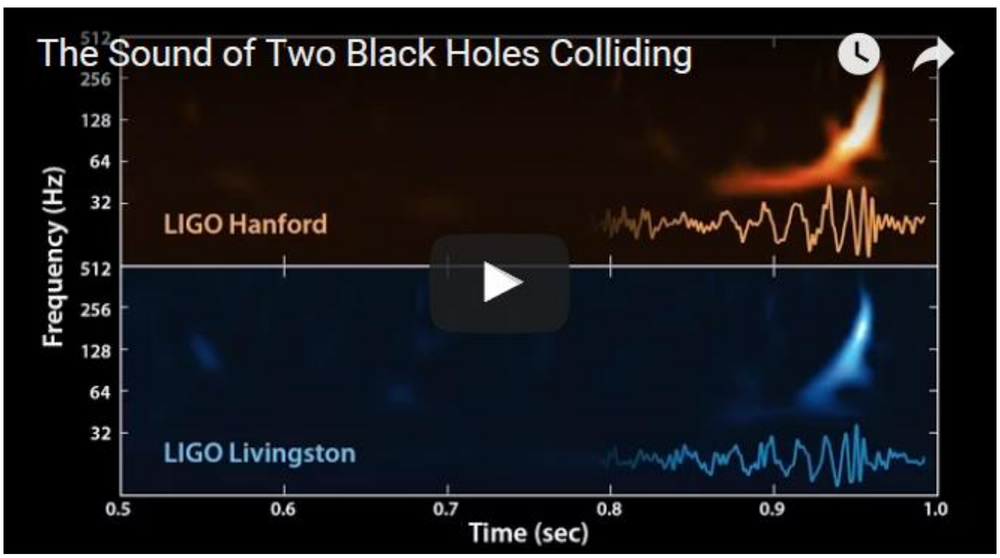
ABSTRACT

On February 11, 2016, Laser Interferometer Gravitational-wave Observatory (LIGO) announced the detection of gravitational waves from two merging black holes. We at Scientific God Journal celebrate Einstein's General Theory of Relativity and congratulate LIGO and all the people and agencies involved for this landmark discovery predicted by Einstein 100 years ago. There is no doubt that this discovery marks the beginning of a new era in astronomy, cosmology and even quantum gravity.

Key Words: LIGO, Einstein, General Relativity, gravitational wave, Black Hole, merger.

The scientists' religious feeling takes the form of a rapturous amazement at the harmony of natural law, which reveals an intelligence of such superiority .... Einstein.



(Credit: LIGO Laboratory)

On February 11, 2016, the World witnessed another great triumph in 21st Century physics - the announcement of the discovery of gravitational wave [1-2] predicted by Einstein 100 years ago [3].

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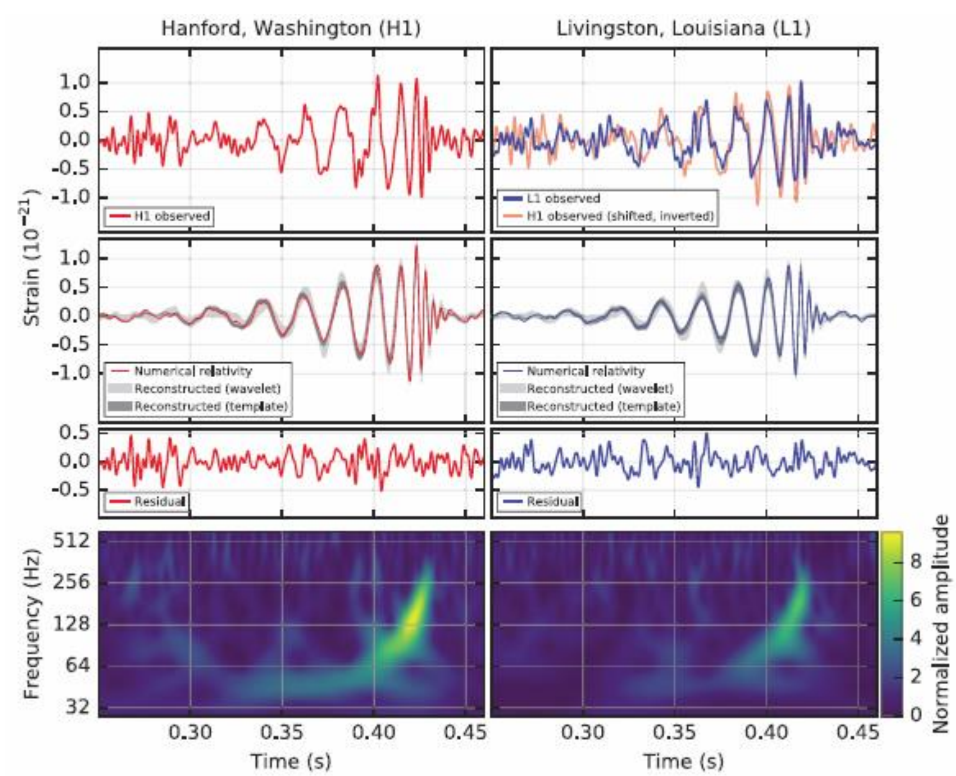
Einstein predicted the existence of gravitational waves in 1916 which was one year after his mathematical formulation of general relativity [3]. After linearizing the weak-field equations, Einstein found that the time variations of the mass quadrupole moment of the source could generate transverse waves of spatial strain that travel at the speed of light [3].

The discovery of the binary pulsar system PSR B1913þ16 by Hulse and Taylor [4] and the subsequent observation of its energy loss by Taylor and Weisberg [5] indirectly demonstrated the existence of gravitational waves.

Now, the LIGO collaboration has just announced direct evidence of gravitational wave and merging binary black holes. In the paper entitled "Observation of Gravitational Waves from a Binary Black Hole Merger" [2], B. P. Abbott et al. state that:

> On September 14, 2015 at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational-Wave Observatory simultaneously observed a transient gravitational-wave signal. The signal sweeps upwards in frequency from 35 to 250 Hz with a peak gravitational-wave strain of 1.0×10^{-21}. It matches the waveform predicted by general relativity for the inspiral and merger of a pair of black holes and the ringdown of the resulting single black hole…These observations demonstrate the existence of binary stellar-mass black hole systems. This is the first direct detection of gravitational waves and the first observation of a binary black hole merger.

The detection results are presented in a combination of several graphics [2]:



(Source: Phys. Rev. Lett. 116, 061102)

Let us recall that on July 4, 2012, the World learned the discovery of the long-sought Higgs Boson (or Higgs like particle) by CERN [6].

Now with both Higgs Boson and gravitational wave apparently in the bags, the unification of Standard Model and General Relativity, the search for the origins of dark matter and dark energy, and the search for the causes of Big Bang and ensuing cosmic expansions become even more pressing.

Besides the mainstream approaches, we point out here some alternatives to think about or work on. Newton assumed that gravity was instantaneous and he would be correct if gravity is *solely* the manifestation of quantum entanglement [7-9]. Indeed, if this is so, gravity is already unified with the quantum theory and we can move on to derive General Relativity from the geometric properties of quantum entanglement (or wave functions) at macroscopic scales.

However, the direct detection of gravitational wave [1-2] and exploratory experiments on non-local gravity [7-9] seem to suggest that: (1) there are multiple sources/causes, such as local (subject to speed of light *c*), non-local (e.g., instantaneous) and/or unknown sources/causes, which contribute to gravitation; or (2) General Relativity, including gravitational wave, is derivable from the geometric properties of different types of quantum entanglement such as quantum entanglement in space and/or quantum entanglement in time [9].

It seems that some "Big Physics" are really paying off. However, the costs in manpower and finance are extremely high. This brings us to the topic of table top experiments. Can fundamental physics still be done in table top experiments besides the billion or multimillion dollar machines? The answer is a resounding "Yes." For example, using simple table top experimental setup, nonlocal gravitational effects were detected indicating nonlocal interaction are one of the origins/causes of gravity [9].

There is no doubt that this direct detection of gravitational wave by LIGO [1-2] marks the beginning of a new era in astronomy, cosmology and even quantum gravity.

References

1. https://www.ligo.caltech.edu/news/ligo20160211
2. B. P. Abbott et al. (2016), Phys. Rev. Lett. 116, 061102.
3. A. Einstein (1916), Sitzungsber. K. Preuss. Akad. Wiss. 1, 688.
4. R. A. Hulse & J. H. Taylor (1975), Astrophys. J. 195, L51.
5. J. H. Taylor & J. M. Weisberg (1982), Astrophys. J. 253, 908.
6. http://press.web.cern.ch/press/PressReleases/Releases2012/PR17.12E.html
7. Hu, H. & Wu, M. (2006), NeuroQuantology 4(4): 291-306; Progress in Physics (2007) v2: 17-21.
8. Hu, H. & Wu, M. (2007), NeuroQuantology 5(2): 190-196; & 5(2): 205-213.
9. Hu, H. & Wu, M. (2013), Prespacetime Journal, 4(11): 1003-1026.