Gravitational waves may reshape our daily lives!

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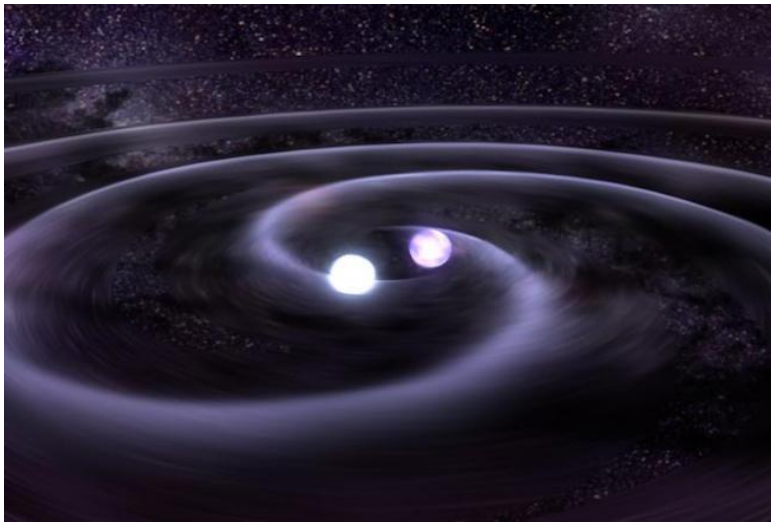

In 2015, the Laser Interferometer Gravitational-Wave Observatory (LIGO) announced that their gravitational wave detectors in America had received a gravitational wave signal generated by the merger of two black holes [1]. It is the first time that human beings directly detect gravitational waves. As soon as the news was released, it made headlines all over the world. But what we will talk about today is another finding of LIGO, which is lesser-known. After that detection in 2015, LIGO detected another gravitational wave signal in 2017, which was generated by the merger of two neutron stars [2]. With the observation of both gravitational and electromagnetic waves, the proof for the existence of gravitational waves became stronger. And I also want to talk about my opinion about how gravitational waves may change our future.

Firstly, what are gravitational waves, and how did we detect them? Let me give you a metaphor to interpret this concept easily. When we drop a stone in a pool, with the stone as the center, the water surface will rise and fall and this motion will spread far away at a certain speed. This is a water wave. Gravitational waves are disturbances or

ripples in the curvature of spacetime, generated by accelerated masses. Gravitational waves propagate as waves outward from their source at the speed of light.

Since gravitational waves are predicted by general relativity, lots of scientists have tried different methods to detect them since the 1960s. In 1974, the first evidence was discovered indirectly. By measuring the orbital decay of the Hulse–Taylor binary pulsar, scientists calculated the energy lost through this process and found that it is exactly the same as the energy loss due to gravitational waves predicted by general relativity. But attempts to probe gravitational waves directly have not gone well. In 1969, Joseph Weber claimed to have detected the first gravitational waves, but this result is not widely recognized. It was not until 2015 that credible direct detection results appeared. LIGO has been using the laser interferometry method to detect disturbances of the spacetime due to gravitational waves. Interferometers are instruments that test the existence of waves. And two years later, they detected the gravitational waves of binary neutron stars. A neutron star is a massive and dying star.

Secondly, why detecting gravitational waves of binary neutron stars is so important? This could be discussed in two aspects. To the community of physicists, it is a great breakthrough in basic science. The detection of gravitational waves completes the final piece of the puzzle of general relativity. As soon as LIGO had detected the gravitational signal of binary neutron stars, observatories all over the world received notification and pointed to this area of the sky. We couldn’t observe any electromagnetic waves from the source in 2015, because no light can escape from black holes. But this time in 2017, we observed both gravitational waves and their companions, electromagnetic waves. This could be incontrovertible evidence for the existence of gravitational waves.

To the community of scientists in other fields, the detection of gravitational waves opens a completely different door for scientists to view the world. Let’s take astronomy for example. Originally, astronomers could only observe the universe

through electromagnetic waves. But gravitational waves enable astronomers to do that in a completely new dimension. Just like, in the past you could only watch a mime, but now you can not only see the actions but also hear the actor's dialogues! In more details, I would like to talk about the research on compact stars. In astronomy, white dwarfs, neutron stars and black holes are categorized as compact stars due to their extremely high density. It was challenging to study their structures in electromagnetic waves in the past. Now with the help of gravitational waves, we may make a great breakthrough in this area.

Finally, how will gravitational waves change our future? We can also divide it into several aspects. For scientists, gravitational waves give us a new way to observe the universe. Some theories in basic science, such as Big Bang and compact stars, may advance. For engineers, the existence of gravitational waves verified general relativity, which helps our world run more precisely. One example is GPS technology. Without consideration of general relativity, we would be getting our location wrong by hundreds of feet.

Indeed, these impacts are fundamental, but will there be anything exciting to do with our daily life? I think the answer is yes. Let me tell you the stories of two scientists, Wilhelm Roentgen and Heinrich Hertz. Wilhelm Roentgen discovered the X-ray in 1895 and was not aware of its benefits. But only a few years later, X-ray was applied to medicine from diagnosis to treatment. The other scientist, Heinrich Hertz, is even more influential. In 1887, he confirmed the existence of electromagnetic waves with experiments. Back then, no one could imagine that electromagnetic waves would bring earth-shaking changes to our lives. In 1893, Nikola Tesla invented wireless telegraphy, making long-distance wireless communication possible. In 1943, the color TV was invented, which has become an essential home appliance in decades. And just over ten years ago, smartphones emerged and nearly everyone owns one now.

So, let's just imagine! Will gravitational waves be used for communication like

electromagnetic waves? I think it is possible because no medium is needed for gravitational wave propagation. The generators of gravitational waves possess a huge amount of mechanical energy. Will we be able to collect gravitational waves to produce energy? Why not? Gravitational waves can be generated and received. Perhaps it is difficult to imagine out of thin air, just like people living in the 19th century were hard to imagine our daily lives in the 2020s. When we apply gravitational waves technology to our daily lives, why can't it also bring about an earth-shaking change? It's entirely possible that gravitational waves may reshape our lives again! That’s why I think the public should care about and continue to fund research in basic science.

Reference

[1] B. P. Abbott et al. Observation of Gravitational Waves from a Binary Black Hole Merger. Phys. Rev. Lett. 116, 061102 (2016)

[2] B. P. Abbott et al. (LIGO Scientific Collaboration and Virgo Collaboration), GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral, Vol. 119, Iss. 16 — 20 October 2017