Fake News from the Universe?

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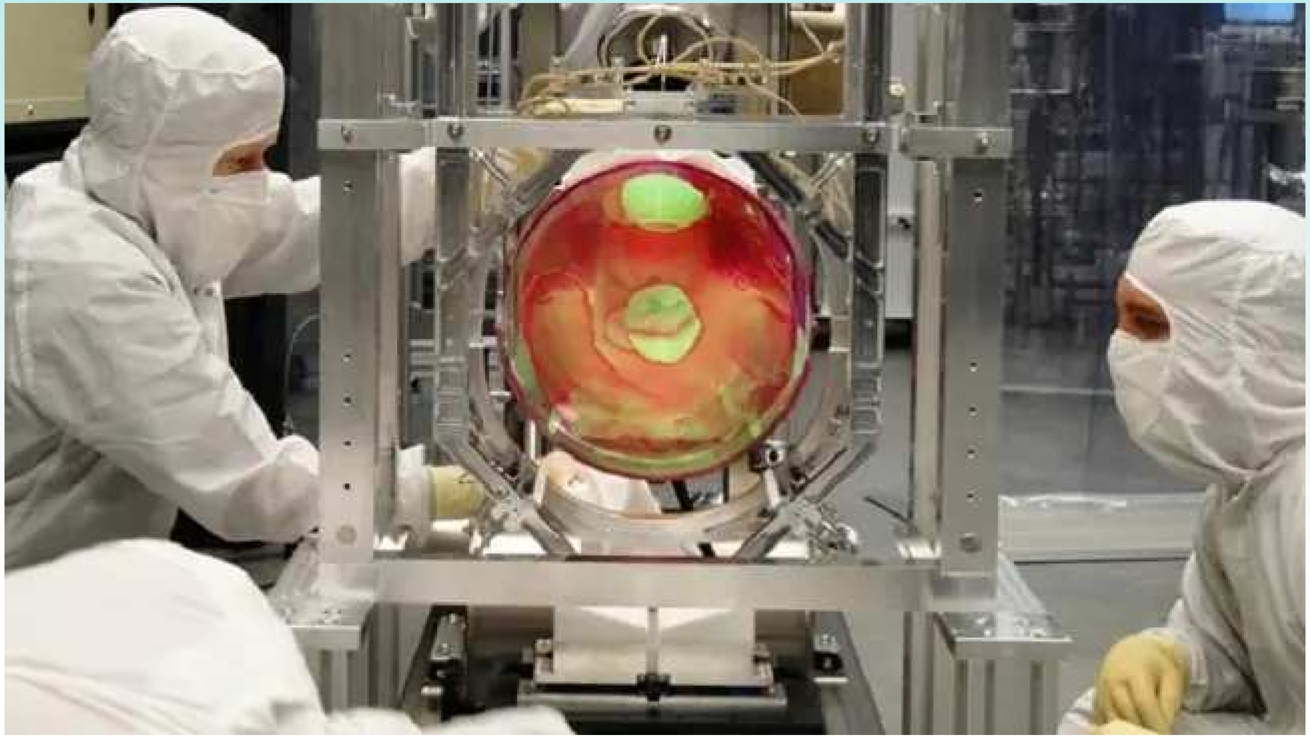
08. Juli 2019 Alexander Unzicker



Laser Interferometer Gravitational-Wave Observatory. Bild: LIGO

The LIGO/Virgo gravitational wave collaboration fails to deliver on its own predictions. It’s time to ask questions

Physics has rarely seen a media echo like the one generated by the press conference held by the National Science Foundation on February 11, 2016. LIGO reported the sensational discovery of gravitational waves from an event on September 14, 2015, exactly 100 years after completion of the General Theory of Relativity and more than 50 years since the search for the mysterious ripples of space-time began.

In the summer of 2017, the collaboration between the LIGO/Virgo laboratories landed another scoop - a gravitational wave signal from merging neutron stars was claimed to have been confirmed by other telescopes. With such independent observations, any remaining doubts seemed to have been removed, and in 2017, Rainer Weiss, Kip Thorne, and Barry Barish would be honored with the Nobel Prize.

Deutsche Version: Fake News aus dem Universum?

A new Golden Age of astronomy to come

In the spring of 2018, the laboratory was shut down for an upgrade in order to make the instruments even more sensitive and reliable. Since April 1, 2019, gravitational waves should eventually contribute to the much-heralded multi-messenger astronomy, as the sensitive laser interferometers and the conventional telescopes for electromagnetic waves would peer out together into the vastness of the universe.

The merger of neutron stars alone was expected to produce dozens of events by 2020 for the current O3 measurement period. With automated detection, the coordinates of each gravitational wave candidate signal are immediately passed on to other telescopes in an alert, to make sure that conventional astronomers would not miss LIGO's discoveries.

This new "window to the universe" has now been opened for more than three months and finds--nothing. In spite of the many alerts from LIGO/Virgo, there has not been a single signal that could be confirmed by the large terrestrial or space telescopes. Astronomers have become slightly annoyed about the wasted observation time and are starting to ask questions. What's happening?

This surprising result provides reason enough to take a closer look at the gravitational wave observations of the last three years. One person who has done so is Andrew D. Jackson from the Niels Bohr Institute in Copenhagen who, with his research group, has already analyzed a wide variety of astronomical data sets with great expertise.

Independent evaluation finds inconsistencies

The group used public data from LIGO to repeat the relatively straightforward analysis. At first, they found no major differences but a rather little oddity.

The statistical disturbances caused by random vibrations in the LIGO laboratories at a distance of 3,000 km had inexplicable correlations. Only the gravitational wave itself should be visible in both places, with a corresponding delay due to the finite propagation time of light. After ignoring the Danish results for a while, a group of eight scientists traveled to Copenhagen in August 2017 to discuss data analysis with their critics.

The gravitational wave researchers had to admit to several mistakes. One of these was that the central figure in Physical Review Letters was not created with the original data but rather prepared for "illustrative purposes," details being added "by eye" - which is embarrassing for an article that was downloaded by hundreds of thousands of people and led to the 2017 Nobel Prize. The informal meeting in Copenhagen was summarized on a blackboard (see below), and one of the leading LIGO scientists, Duncan Brown, promised to persuade his colleagues to correct that misimpression, though evidently, so far, without success.

Image, detail) The Niels Bohr Institute: "Duncan [Brown] will argue for the correction of the Figure 1 caption in Physical Review Letters."

Brown, who appears in front of the board in another photo with Andrew D. Jackson and six other researchers, has since left the collaboration. In November 2018, the "pedagogical" treatment of the image and other negligence led to a headline in the New Scientist: "Great Doubts about LIGO's discovery of gravitational waves." So far, journalists have been unsuccessful in finding out which LIGO researcher was responsible for the criticized labeling of the figure.

In the meantime, Jackson, who likes to emphasize that he is the spokesperson rather than the leader of the group, had revealed another LIGO trickery: a so-called template, a theoretically calculated signal used for the analysis of GW150914, was subsequently replaced by a seemingly better-fitting one. Yet, the second template differs dramatically in terms of source location1, raising more troubling questions.

Clean statistics sees still (almost) no result

However, there is an even more explosive result of the Copenhagen group result than the inexplicable correlation in the detector noise. LIGO/Virgo analyzes the data by comparing it to a huge database of theoretically expected signals, the templates. Despite being helpful for, say, determining black hole masses, such a method is methodically highly questionable because it implies a crucial prejudice: the existence of gravitational waves.

Andrew D. Jackson and his group therefore proposed a method based solely on statistics that yields an unbiased calculation of the correlated signal seen by the two laboratories. If one wants to avoid a false-positive interpretation of random noise, this is indeed the only clean way to follow.

It is quite stunning that, with this sober method, none of the more than 20 claimed gravitational wave signals could be verified - except for the very first event, GW150914, in September 2015. Now, one might argue that this first event proved the existence of gravitational waves and eliminated the concern that subsequent signals were caused by an undue filtering of random noise rather than by gravitational waves.

Secrecy surrounding the September event

The problem is, however, that LIGO researchers were by no means as convinced of the authenticity of GW150914 as was communicated to the public. The first impression for almost everyone was that the wave was too perfect to be credible. One should be aware that it had been long-standing practice to generate artificially dummy signals, so-called blind injections, in order to test whether the collaboration would be able to detect a real signal.

The relevant software was also completed in September 2015, as documented by the laboratory's logbook.2 Theoretically, it was possible that the observed signal was a blind injection--or even a manipulation by unauthorized persons. Back then, the facility was still operating in test mode without any safety precautions.3

In order to rule out an artificially generated signal, on September 18, 2015, Duncan Brown asked by email the three members of the blind injection team—Jeffrey Kissel, Christian D. Ott, and Michal Bejger—to comment on this possibility. All denied a signal injection in response to the email as well as in another interrogation by LIGO Director David Reitze, who also testified on the issue before the U.S. Congress.

Not mentioned to the U.S. Congress (though it would have been interesting) was a report from October 2015, still unpublished, that discussed various scenarios in which manipulation of an artificial signal would have been possible, requiring, however, considerable insider knowledge (see excerpts). Apart from the blind injection team, presumably very few people did have these capabilities.

Internal LIGO document (authored by Matthew Evans) discussing possibilities of signal forgery that could not be completely ruled out.

Of course, this is far from proof that manipulation took place. Given the considerable doubts among its leaders, it would have been appropriate, however, for LIGO4 to make its own investigations more transparent. Even sociologist Harry Collins, who quite sympathetically describes the story of the discovery in his book Gravity's Kiss, harshly criticized the extensive secretiveness in LIGO's policies.

Illustrating the state of mind of researchers, longtime LIGO director and Nobel Laureate Barry Barish confessed that he had breathed a "sigh of relief" in December 2015 when a second signal was found in the data. Whatever weights one may give to such circumstantial utterings, it’s a fact that, after three more years and with three times the initial detector sensitivity, GW150914 is still the strongest signal of all -- a coincidence that gets stranger every day.

GW150914 is by far the strongest signal to date and the only one that can be distinguished from noise by purely statistical methods. Image: Teresita Ramirez, Geoffrey Lovelace, SXS Collaboration, LIGO/Virgo Collaboration.

Postdiction instead of prediction

Therefore, for many who follow the latest developments in science, the strongest evidence for the observation of gravitational waves is the GW170817 signal discovered in August 2017 by LIGO and then confirmed by the Fermi (NASA) and Integral (ESA, though with very weak signal) gamma-ray telescopes. At any rate, this is how it was presented at the press conference.

To be a little bit more precise, however, Fermi had sent the notification email *first*, and LIGO needed four hours to "predict" the sky position--which matched the coordinates already known. The misleading impression that LIGO was the first one had a simple origin: they explicitly requested a modification to the subject line of the alert mail (see picture).

Note the subsequent change of the subject line by LIGO/Virgo.

In addition to these inconsistencies, well-known experts have challenged the interpretation that the signal comes from the merger of two neutron stars. According to authors from nine renowned institutions, this would have required "extreme models" of the corresponding galaxies. An Italian group assigns the observed gamma-ray signal (or the afterglow) to a fusion of white dwarfs, which cannot emit gravitational waves of the required strength. Thus, considerable doubts remain as to whether GW170817 was really confirmed by other telescopes or even whether it was a gravitational wave.

Gravitational waves: please show up!

With three laboratories (Hanford, Livingstone, and Pisa) and unprecedented measurement sensitivity, it should be easy to discover more events like GW170817. While LIGO previously had hoped to find as many as fifty such signals, the expectations were later modified to ten.

Steadily growing doubts: the likelihood that the "event" seen on May 10, 2019, was a binary neutron star (BNS) has gradually decreased to the level of a "false alarm," while reasons for the adjustment remain unclear.

However, since the beginning of the measurements at the beginning of April, there has not been any event worthy of attention. Instead, there have been many false alarms, surprising to the point of incomprehensibility. Why are there so many simultaneous "glitches" in three laboratories?

Particularly embarrassing was the one of May 10, 2019, in which the confidence level of the identification dropped from 98 percent to 85 percent and, finally, to 42 percent, after the alerted telescopes saw nothing. More mispredictions can be found here and here.

As a result, LIGO has become more cautious about unnecessarily stirring up their astrophysics colleagues. Signal names now receive two-letter suffixes to indicate how many "events" on each day showed a match with the theoretical wave templates. For example, S190524q means that 16 other events, a to p, were discarded for unknown reasons.

Grit your teeth and get to it?

> Nothing is so difficult as not deceiving oneself.
>
> *Ludwig Wittgenstein, German philosopher*

So far, the optimism in the community seems to be undisturbed: "It is only a matter of time before the next neutron star or NSBH merger is discovered, for which a luminous source can then be found."

Of course, it is possible that LIGO will find signals in the upcoming months, to which an electromagnetic counterpart can be unambiguously assigned by other telescopes, thus providing indisputable evidence for gravitational waves. But in case this prediction fails in the O3 run, one has to be equally clear and avoid the temptation of simply retuning the astrophysical models and arguing ex post facto that verifiable events are far less common than expected. Gravitational wave physics has done so for far too long.

Rather, the consequences of non-observation should be defined now and not at the end of the O3 run. If the laboratories continue to see nothing that others can confirm, it’s a clear indication of a seemingly unsatisfactory, yet perhaps very important, result of the technical marvels: there might not be any gravitational waves.

In the last sixty years, gravitational wave physics has continuously been forced to admit that the signals were weaker than predicted (e.g., the radiation from pulsars). In 2009, Virgo director Adalberto Giazotto stated that no detection of gravitational waves should be claimed without confirmation by coincident electromagnetic signals - something that had been conveniently forgotten in the feeding frenzy of 2016.

Seek and ye shall find

Generally speaking, science suffers from a bias in favor of "discoveries" because single events cause selective attention that plays a major role in shaping the convictions of a research field. Subsequent investigations, though usually more reliable, receive much less attention. The same holds true for a gradual failure of predictions that cannot be assigned to a fixed date. Science historian Gary Taubes once succinctly remarked:

> Nobody ever won a Nobel for proving that something didn't exist or some theory was wrong.
>
> *Gary Taubes*

Gravitational wave physics is entering a phase in which it is crucial to interpret the observations impartially. Therefore, a statistical detection algorithm such as the one proposed by the Copenhagen Group has to be implemented. One does not have to be an expert in signal analysis to realize that fishing for similarities with expected signals in a noisy background bears the danger of false-positive events. LIGO/Virgo's current practice is designed to produce such illusions, and sticking to the faulty method will not convince the scientific community in the long run.

Dr. Alexander Unzicker is a German theoretical physicist and science writer. The German edition of his book Bankrupting Physics (Palgrave Macmillan, 2013) was awarded the "Science Book of the Year" distinction, an award that was also given to Richard Dawkins and Yuval Harari. In his latest book, Einstein's Lost Key, he discusses a variable speed of light interpretation of general relativity.

(*Alexander Unzicker*)