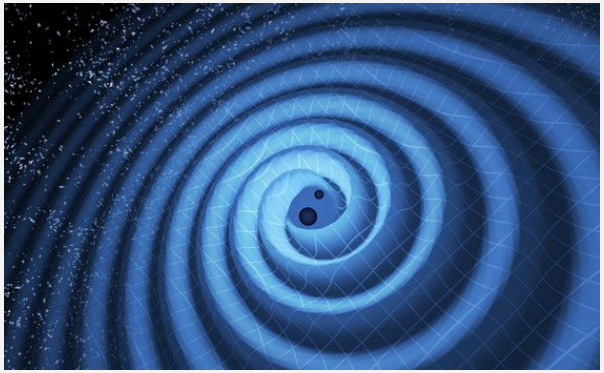
Gabriela Gonzáles is an Argentinian professor of physics and astronomy at Louisiana State University. She has been a member of the LIGO scientific collaboration since 1997, where she works on the detection of gravitational waves. She is a pioneer in the search for gravitational waves produced by compact binary systems in the last orbits of their lives, and was part of the team who detected the first of these signals in 2015.

LIGO Livingston

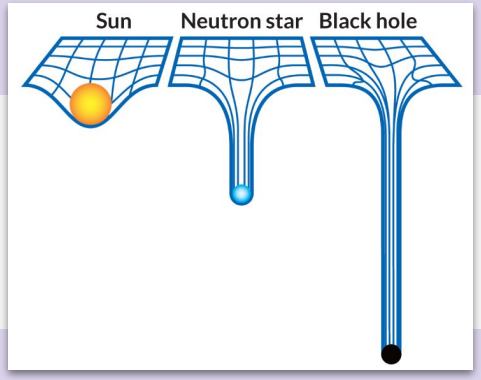
Gabriela Gonzáles studies **gravitational waves**

Predicted by the Theory of General Relativity (GR), **gravitational waves** are **ripples in spacetime** which arise when massive astronomical objects orbit around each other in close proximity, sometimes leading to mergers .

These waves **propagate** outward from their source, much like waves on a pond. Instead of water, they carry energy across the universe.



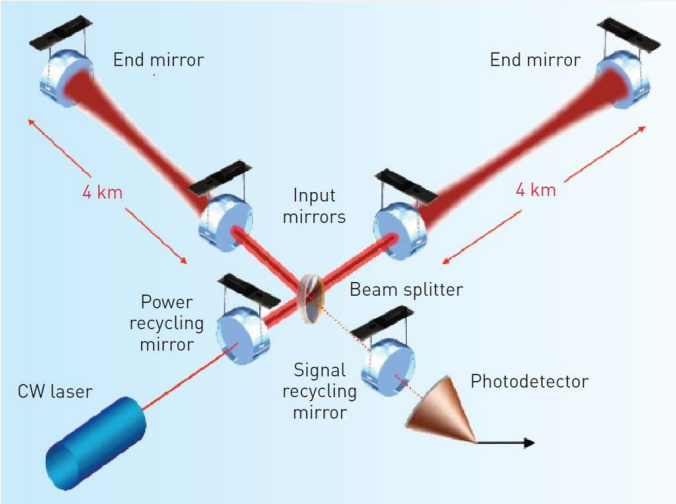
Visualization of gravitational waves



Objects causing such phenomena are usually **black holes** or **neutron stars**, compact objects usually found in binary systems.

LIGO and **Gabriela Gonzáles**

Gonzáles directly tests the theory of GR by using a giant interferometer known as the **laser interferometer gravitational-wave observatory** (LIGO). This is actually a set of two detectors located in Hanford, Washington and Livingston, Louisiana.



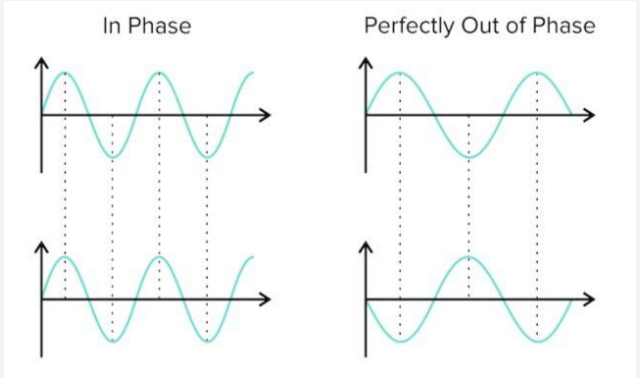
LIGO consists of two **L-shaped arms**, each 4 kilometers in length, arranged at a right angle to each other. The arms are placed in a **vacuum** to prevent **interference** from air particles or **vibrations** that could disrupt the precision measurements.

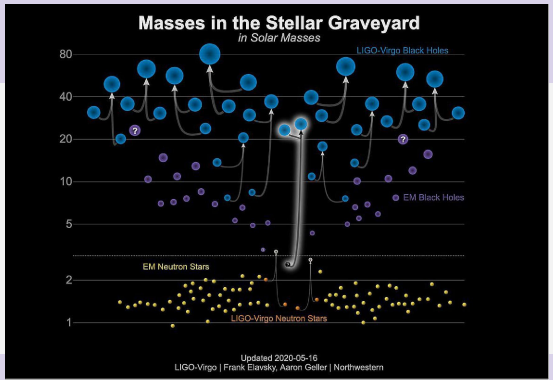
At the center of the L-shape, a **laser** is fired into a device called a **beam splitter**, which divides the laser into two beams. Each beam is sent down one of the two perpendicular arms.

LIGO and **Gabriela Gonzáles**

The length of LIGO's arms enables gravitational waves to stretch and compress these structure's distances by incredibly small amounts, allowing for precise measurements to be made.

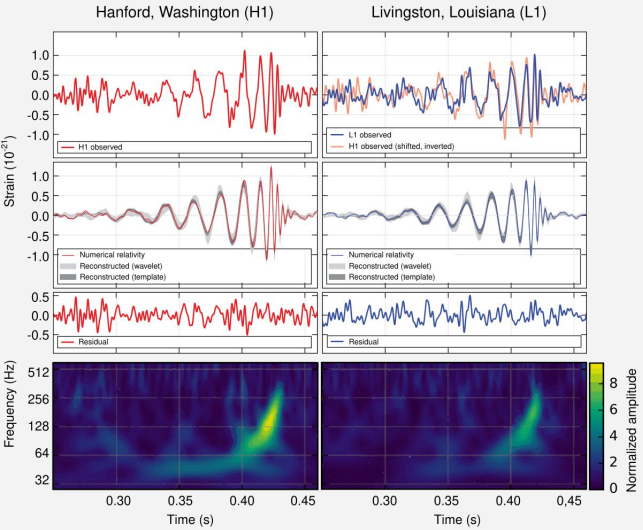
When a gravitational wave hits the Earth, the wobbling of the arms causes the laser to go in and out of **phase** periodically.





It is precisely these periodic measurements that Gabriela Gonzales uses to characterize binary systems and determine crucial information such as **mass** and **orbital period**.

Gabriela Gonzáles's contribution to the first gravitational wave detection



2015 data

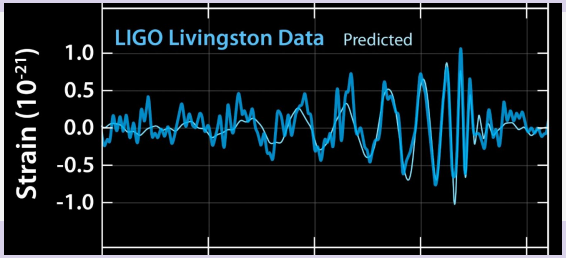
The **first gravitational wave detection** was made on the 14th of September 2015. Both LIGO observatories detected a waveform coming from a **binary black hole merger (GW150914)**, matching the predictions of general relativity.

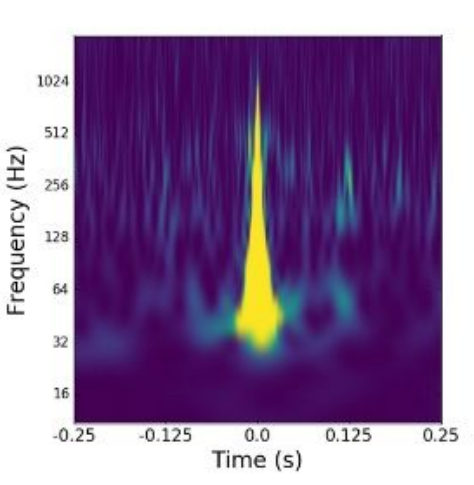
Gonzáles was a leading member of the team responsible for the data analysis of this detection. This required sophisticated algorithms such as **Matched Filtering** and **Bayesian Inference** to filter out noise and identify the faint signals corresponding to the actual source.

Additionally, as one of the **spokespersons** for the LIGO collaboration, González played an important role in communicating the significance of the discovery to the public.

Gabriela Gonzáles work in data analysis and reduction

González has played a pivotal role in improving the **sensitivity** of LIGO detectors, reducing **background noise** and unwanted data captured by the instrument.





Transient example

In a recent 2024 paper, she presented her team's efforts to enhance the instrument's sensitivity through multiple instrumental inspections, leading to a reduction in **transient noise** due to **glitches**.

She has also improved software tools used to analyze the detector's data quality. This includes **Machine Learning-Based Glitch Classification,** where she uses **neural networks** to classify and identify various types of glitches.

Gabriela González; a pioneer in her field

In 2008, Gonzales became the **first woman** to receive a **full professorship** in the department of physics at the Louisiana State University.

She has won a multitude of awards such as the **Bouchet Award** in 2007, the **Bruno Rossi Prize** in 2017 and the **National Academy of Sciences Award for Scientific Discovery** in 2017

She is a firm believer that science would be better off with an equal amount of women and men, along with other diverse groups, and advocates for the world to understand that physicists are regular people too.

In an interview at Syracuse University, when asked about how she feels with regards to being a role model for young women and Latinas, she answered:

“I want to show them that not all physicists are geniuses—or are male, gray haired, or eccentric. Most of them are fairly normal people. We need to make sure young boys and girls don’t buy into the “mad scientist” stereotype. Instead, they need to understand that contributions to science—or any field, for that matter—require curiosity and hard work. This approach has served me well.”

Resources:

- Gabriela Gonzales academic website: https://www.phys.lsu.edu/faculty/gonzalez/
- Wiki: https://en.wikipedia.org/wiki/Gabriela_Gonz%C3%A1lez
- Syracuse Article + slide 6 image: https://news.syr.edu/blog/2019/01/04/physicist-gabriela-gonzalez-g95-reveals-how-syracuse-prepared-her-to-make-science-history/
- Ted Talk: https://www.ted.com/speakers/gabriela_gonzalez
- 2024 paper: https://www.researchgate.net/publication/383754065_LIGO_Detector_Characterization_in_the_first_half_of_the_fourth_Observing_run

Images:

- Gabriela Gonzales, slide 1: https://news.syr.edu/blog/2019/01/04/physicist-gabriela-gonzalez-g95-reveals-how-syracuse-prepared-her-to-make-science-history/
- LIGO, slide 1 and 3: https://www.ligo.caltech.edu/LA
- Gravitational waves, slide 2: https://www.ligo.caltech.edu/LA
- LIGO laser, slide 3: https://www.optica-opn.org/home/articles/volume_26/march_2015/features/ligo_finally_poised_to_catch_elusive_gravitational/
- Waves, slide 4: https://www.shemmassianconsulting.com/blog/waves-and-sound-mcat
- Stellar Graveyard, slide 4: https://www.ligo.caltech.edu/image/ligo20200902a
- LIGO data, slide 5: https://en.wikipedia.org/wiki/First_observation_of_gravitational_waves
- LIGO Livingston data, slide 6: https://www.ligo.caltech.edu/image/ligo20160211a
- Gabriela Gonzales, slide 8: https://www.youtube.com/watch?v=DywnIbQZmvQ