



Welcome to LIGO! The Most Sensitive Instrument in the World



Camilla Compton (she/her) - Operations Specialist LIGO Hanford Observatory - 2022







WHAT ARE WE SEARCHING FOR?

LIGO TECHNOLOGY





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Name: Camilla Compton Age: 28 Hobbies: Running, Climbing, Skiing Major: Physics Job: Operations Specialist



LIGO – Laser Interferometer Gravitational-Wave Observatory





THE LIGO CONTROL ROOM

2 PHASES

19:39: 14

1:39: 17 12336035 76

Observing Getting data

Commissioning

Making improvements

HILL HE FAXMER DA



Everything clean to maintain vacuum





LIGO – Laser Interferometer Gravitational-Wave Observatory



Gravitational Wave Observatories





WHAT ARE WE SEARCHING FOR?

LIGO TECHNOLOGY





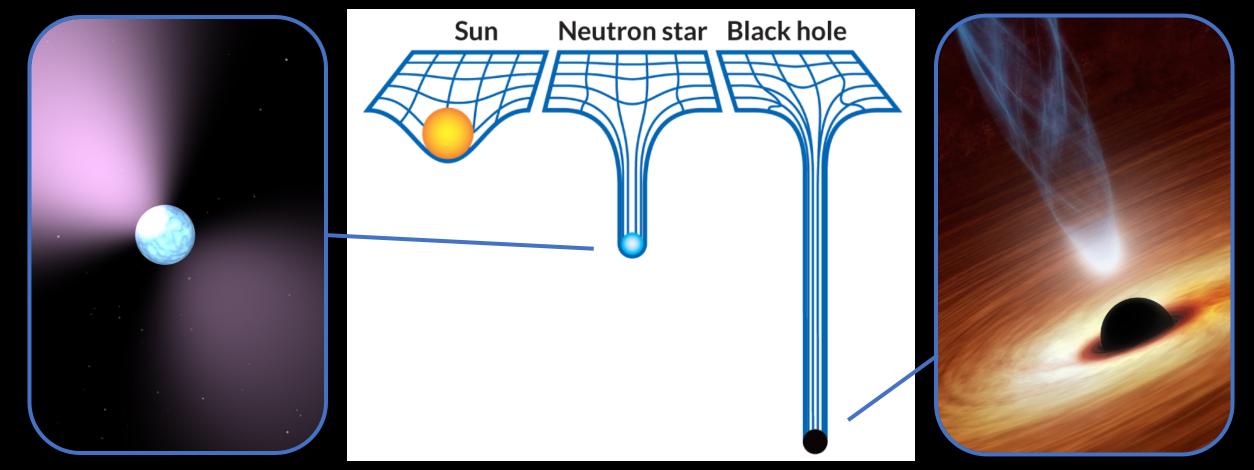
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BLACK HOLES AND NEUTRON STARS

Credit: NASA JPL

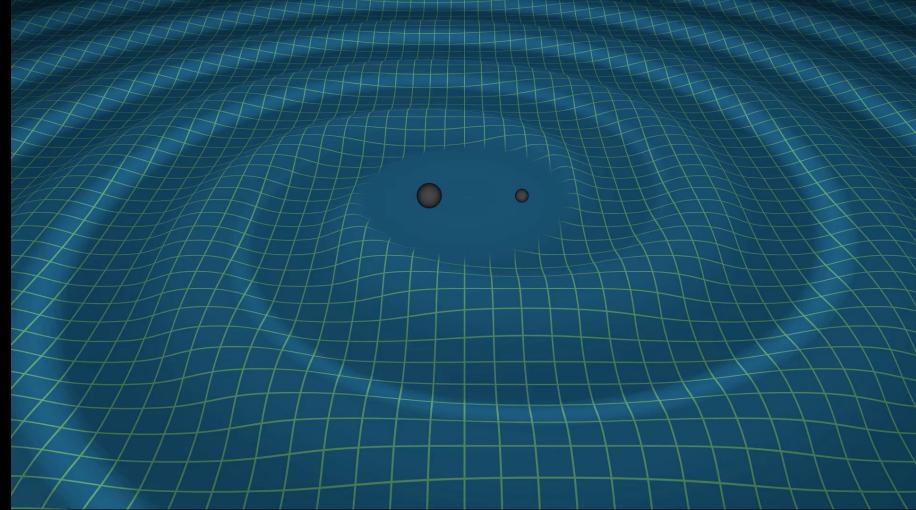


Neutron Star is left over from the gravitational collapse of a star after a supernova explosion.

Black hole is a very object so dense that even light cannot escape it's gravitational field.



WHAT ARE GRAVITATIONAL WAVES? THEIR EFFECT ON SPACETIME



GW150914 Blackholes with 36M_{solar} and 29M_{solar} combine to make a bigger Blackhole with 62M_{solar}. Remaining 3M_{solar} ejected as energy.

Credit: LIGO/T. Pyle



WHAT ARE GRAVITATIONAL WAVES? THEIR EFFECT ON SPACETIME

Credit: LIGO/R. Hurt

This is exaggerated, we want to be sensitive to the whole earth moving by the diameter of a proton!

Scale of Effect Vastly Exaggerated



GRAVITATIONAL WAVES - EFFECT ON SPACE

VILLEN

To detect gravitational wave signals we need a strain = $\frac{\Delta L}{L} = 10^{-22}$

Length of arms = $L = 4000 \text{m} \sim 10^3 \text{ m}$

So we need to detect changes in length $\Delta L = 10^{-18} \text{ m}$



12:41:04 UTC = 4:41am in the LIGO Hanford Control Room



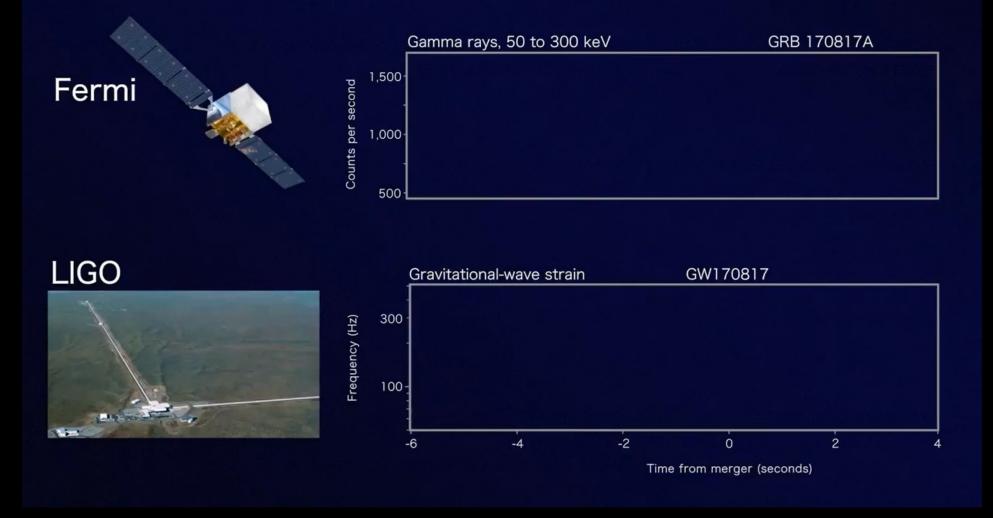


12:41:<u>06</u> UTC = 4:41am in the LIGO Hanford Control Room



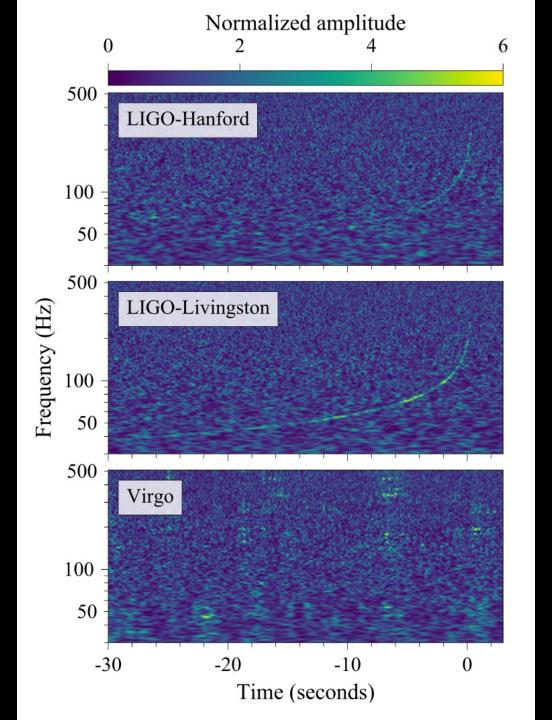


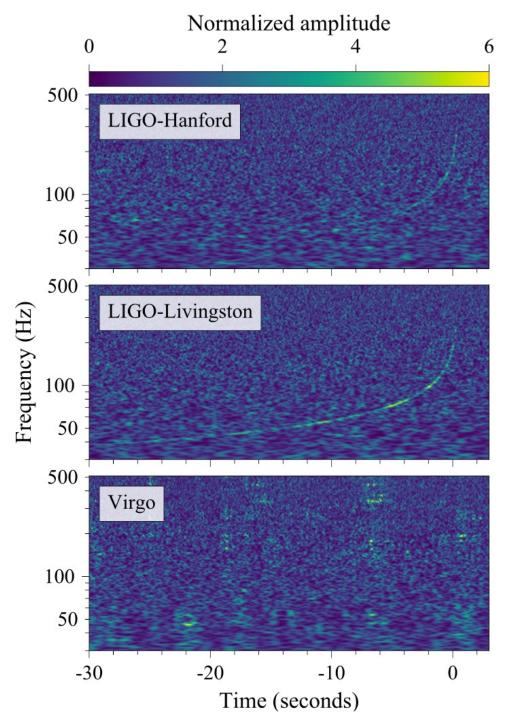
FIRST DECTECTION OF NEUTRON STAR MERGER – GW170817

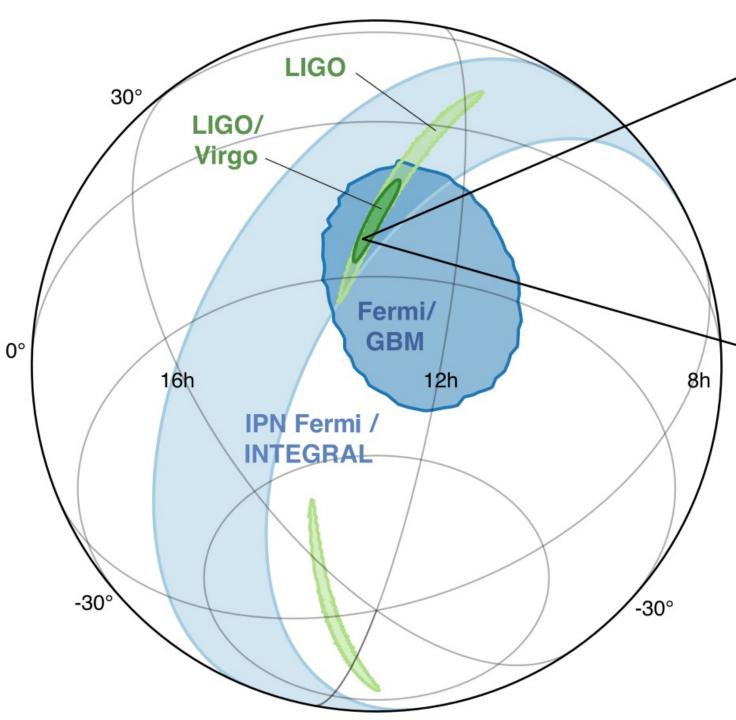


Credit: NASA GSFC & Caltech/MIT/LIGO Lab





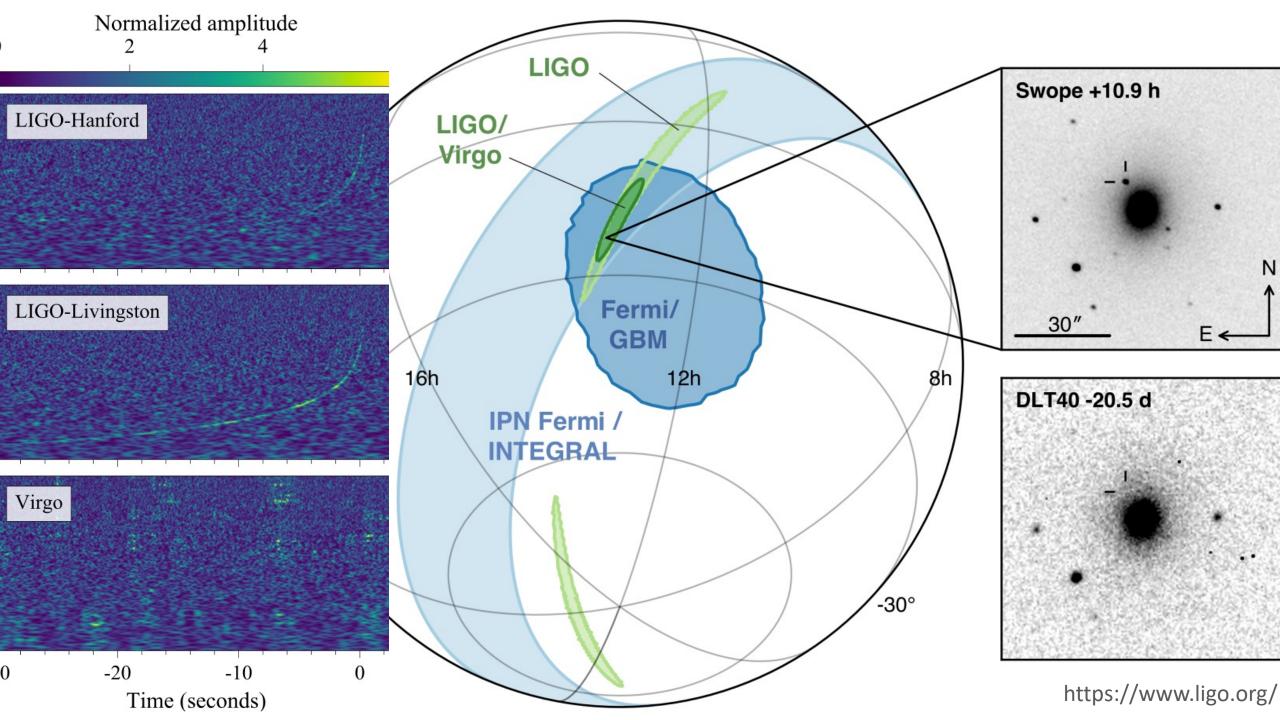






+10 hours 52 minutes

Concuelo Conzález Ávila 201





GW170817



90 Gravitational Wave Detections!!

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GW150914	GW151012	GW151226	GW170104	GW170608	GW170729	GW170809	GW170814	GW170817	GW170818	GW191103_012549	GW191105_143521	GW191109_010717	GW191113_071753	GW191126_115259	GW191127_050227	GW191129_134029	
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GW170823	GW190408_181802	GW190412	GW190413_052954	GW190413_134308	GW190421_213856	GW190424_180648	GW190425	GW190426_152155	GW190503_185404	GW191204_110529	GW191204_171526	GW191215_223052	GW191216_213338	GW191219_163120	GW191222_033537	GW191230_180458	
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GW190512_180714		GW190514_065416	GW190517_055101	GW190519_153544	GW190521	GW190521_074359	GW190527_092055	GW190602_175927	GW190620_030421	GW200112_155838	GW200115_042309	GW200128_022011	GW200129_065458	GW200202_154313	GW200208_130117	GW200208_222617	
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											CW200310 003254						
GW190630_185205	GW190701_203306	GW190706_222641	GW190101_093326	GW190708_232457	GW190719_215514	GW190720_000836	GW190727_060333	GW190728_064510	GW190731_140936	GW200209_085452	GW200210_092254	GW200216_220804	GW200219_094415	GW200220_061928	GW200220_124850	GW200224_222234	
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GW190803_022701	GW190814	GW190828_063405	GW190828_065509	GW190909_114149	GW190910_112807	GW190915_235702	GW190924_021846	GW190929_012149	GW190930_133541	GW200225_060421	GW200302_015811	GW200306_093714	GW200308_173609	GW200311_115853	GW200316_215756	GW200322_091133	
	Zoheyr Doctor / University of Oregon / LIGO-Virgo Collaboration											Zoheyr Doctor / CIERA / LIGO-Virgo Collaboration					





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ABOUT LIGO

-4km

Y-arm

90°

4km~

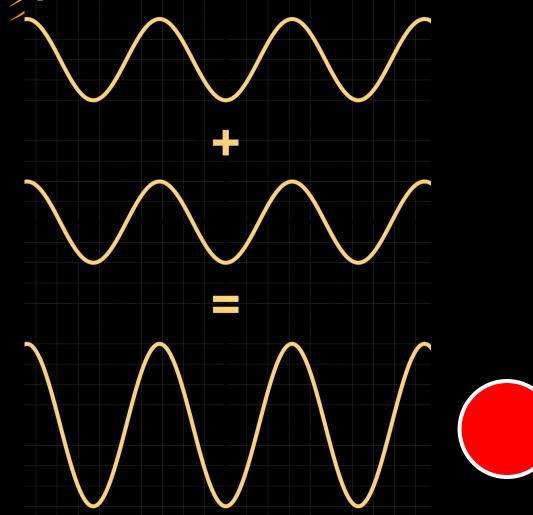
Lasers!

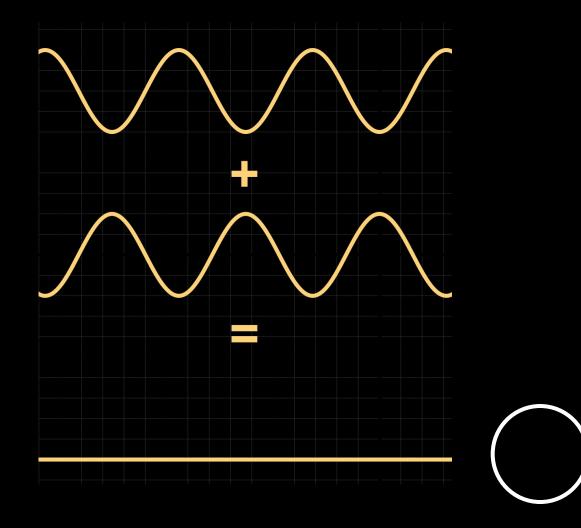
X-arm

Name: Laser Interferometer Gravitational-wave Detector Age: 28 (build started 1994) Cost: \$1 billion Signals detected: 90 Size: 2.5 miles



THE BASICS OF AN INTERFEROMETER



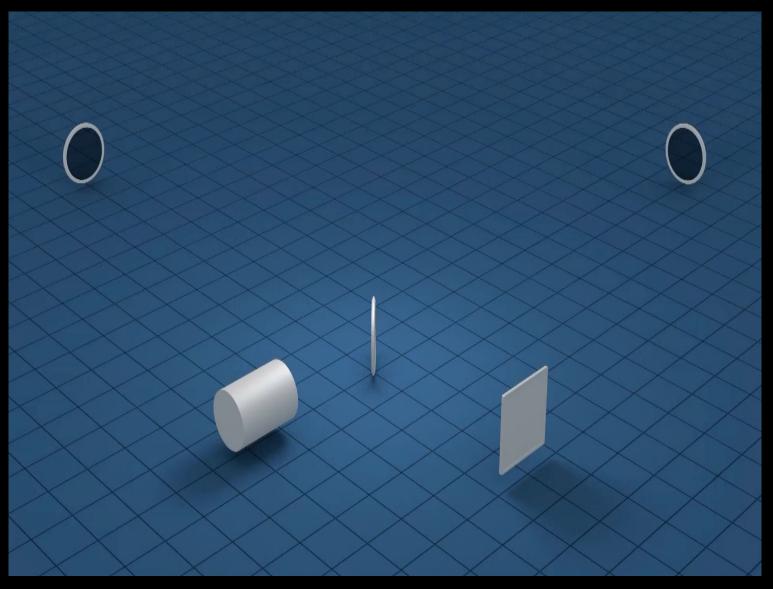


Constructive Interreference

Destructive Interreference



THE BASICS OF AN INTERFEROMETER



Credit: LIGO/T. Pyle

$\Delta L = 10^{-18} \text{m} = 0.0000000000000001 \text{m}$



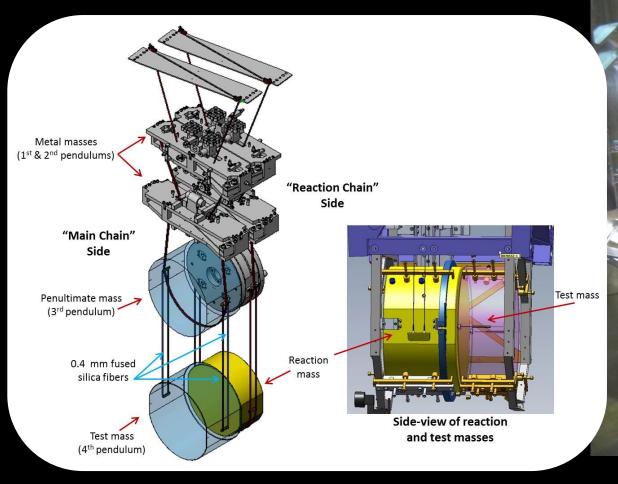


Shhhhh.....



Isolated from noise

SUSPENSIONS and VACUUM





Credit: Matt Heintze/Caltech/MIT/LIGO Lab









LIGO Scientific Collaboration







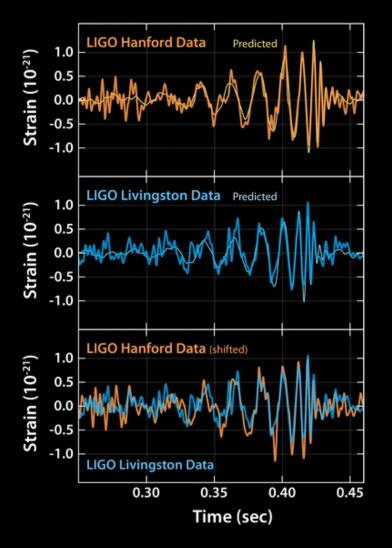
Have you got any Questions?

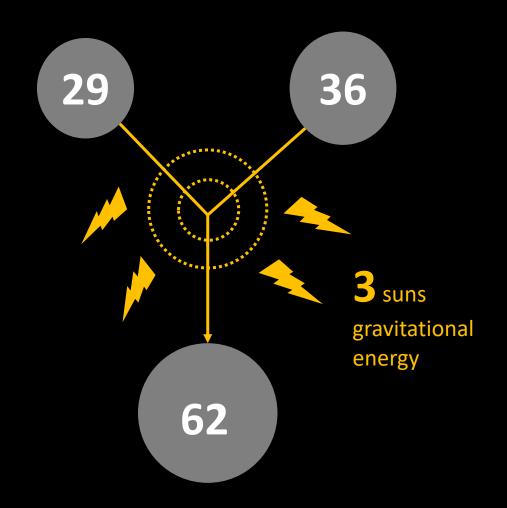


STORY BY DENNIS UGOLINI



FIRST DECTECTION – GW150914





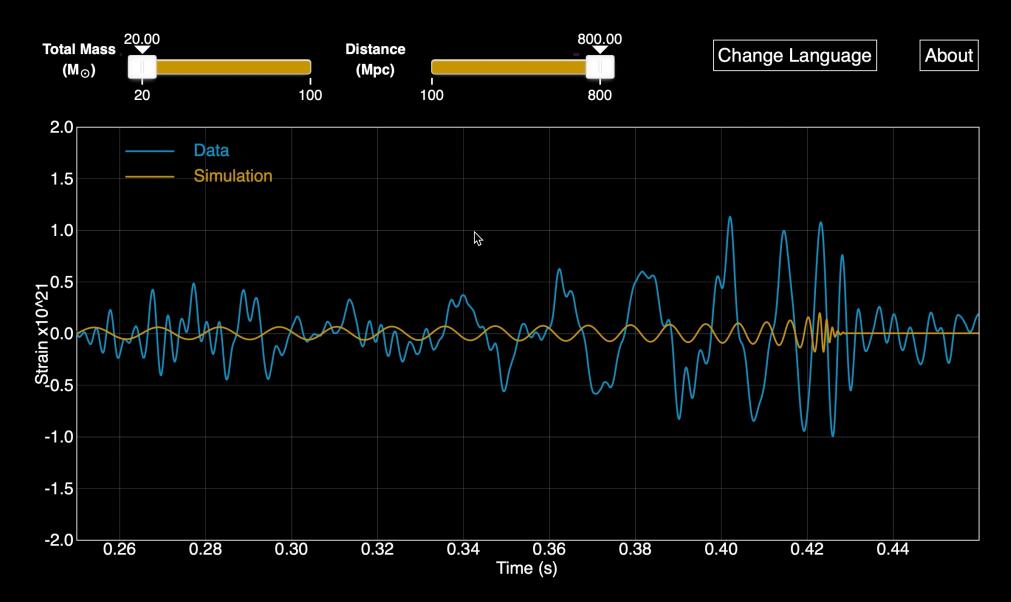
GW150914 Blackholes with 36M_{solar} and 29M_{solar} combine to make a bigger Blackhole with 62M_{solar}. Remaining 3M_{solar} ejected as energy.

http://data.cardiffgravity.org/waveform-fitter/

Waveform Fitter

RGO

KAGR/





LOCATING GRAVITAIONAL WAVE ORIGIN



time = distance ÷ speed

- = 3002km ÷ speed of light
- = 3,002,000m ÷ 300,000,000m/s
- = 10ms between detections.