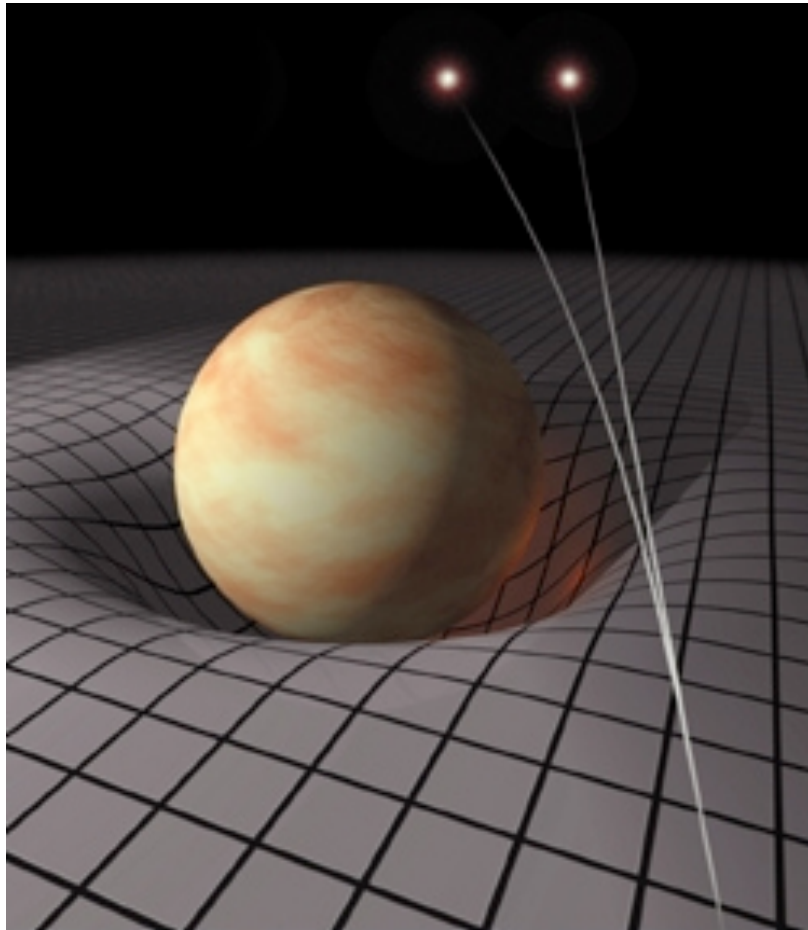


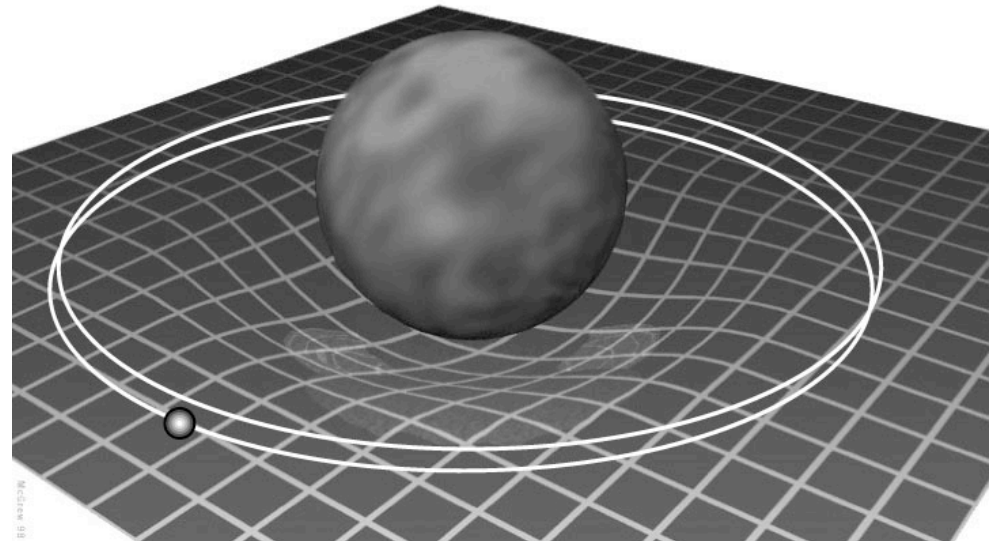


# What Can We Learn From Gravitational Waves?

Tiffany Summerscales  
Andrews University  
On behalf of the LSC



Space tells matter how to move.  
Matter tells space how to curve.  
– John A. Wheeler



<http://preposterousuniverse.com/spacetimeandgeometry/covercrop.jpg>  
<http://zebu.uoregon.edu/ph121/hb/amy/merc.jpg>

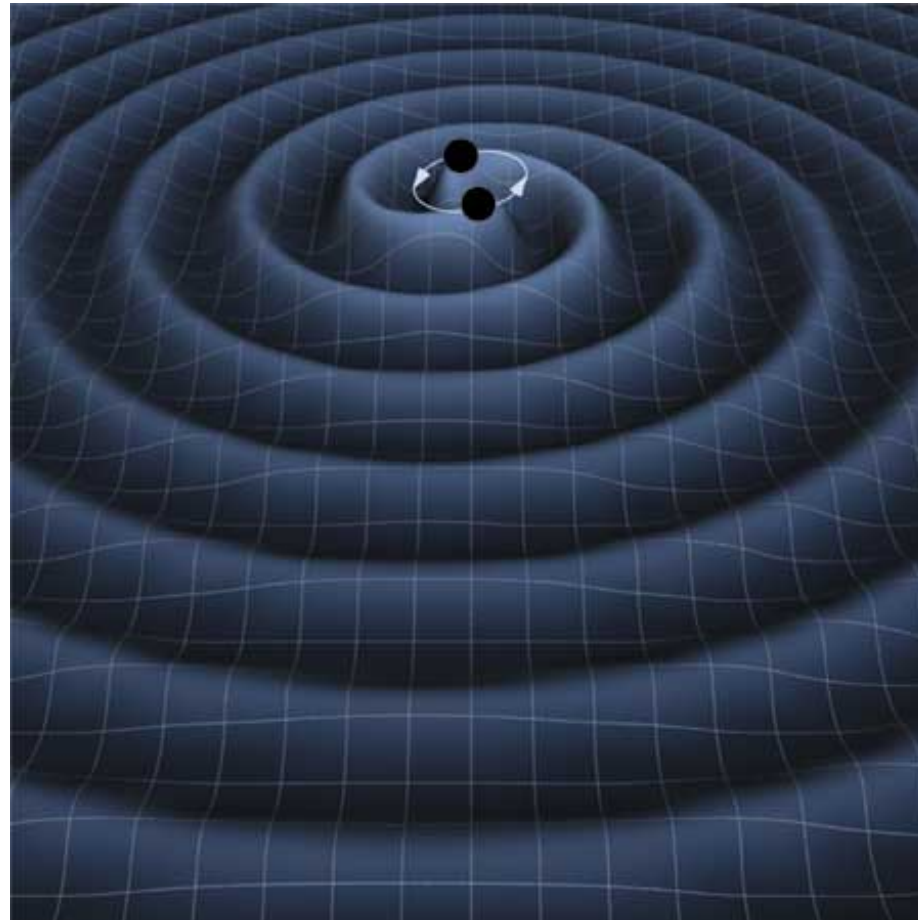




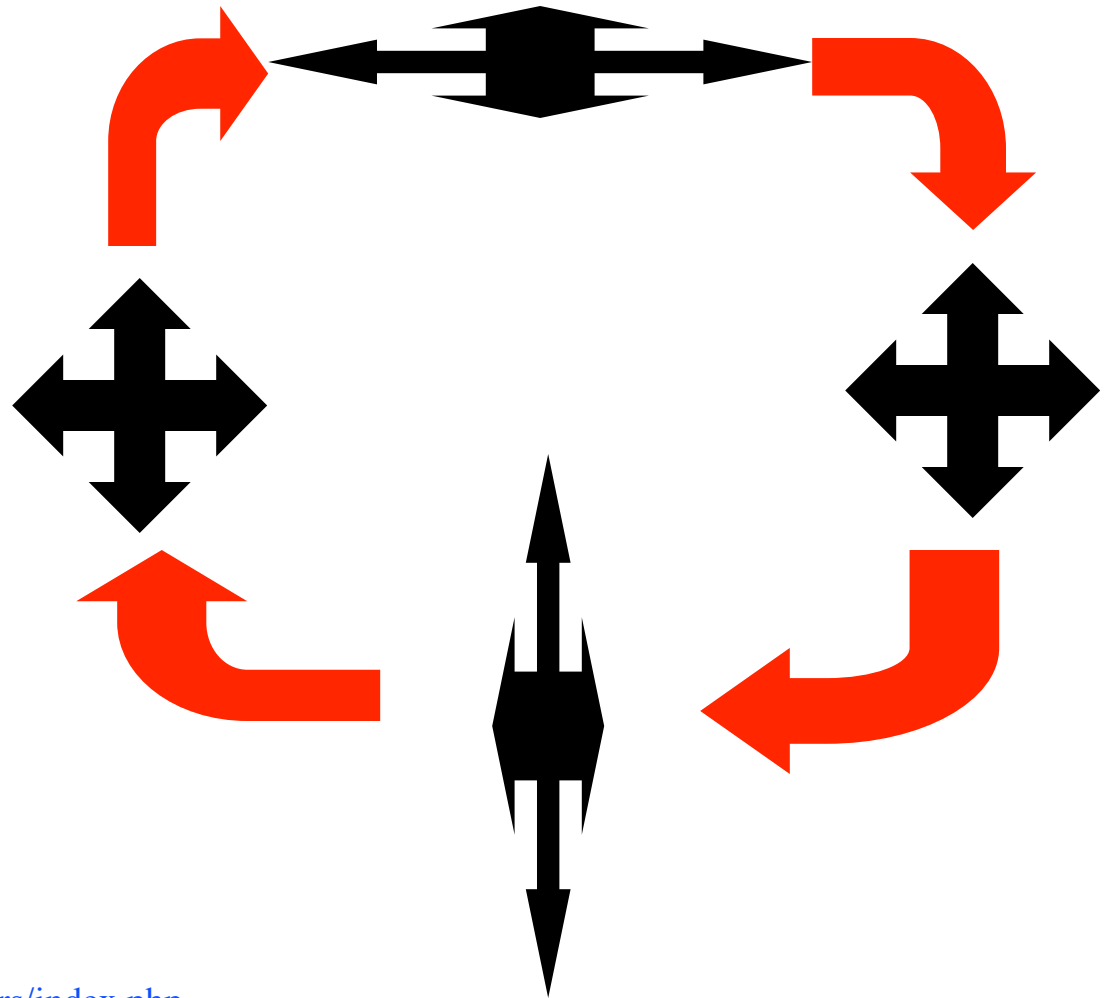
# What is a Gravitational Wave?



- Change in matter distribution = Change in curvature
- Propagating change in curvature = A Gravitational Wave

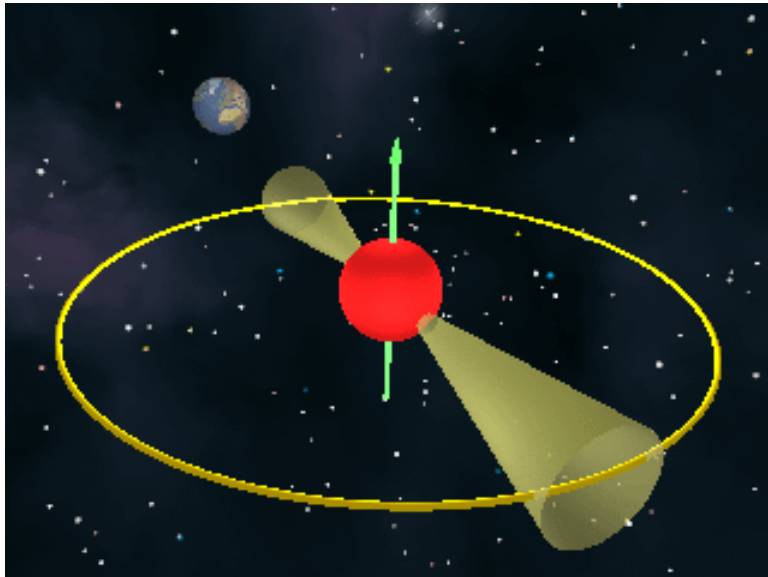


<http://lisa.jpl.nasa.gov/gallery/binary-wave.html>



Animation from <http://www.ligo-la-caltech.edu/Posters/index.php>





<http://www.jb.man.ac.uk/news/neutronstar/neutronstar.gif>

[http://nobelprize.org/nobel\\_prizes/physics/laureates/1993](http://nobelprize.org/nobel_prizes/physics/laureates/1993)

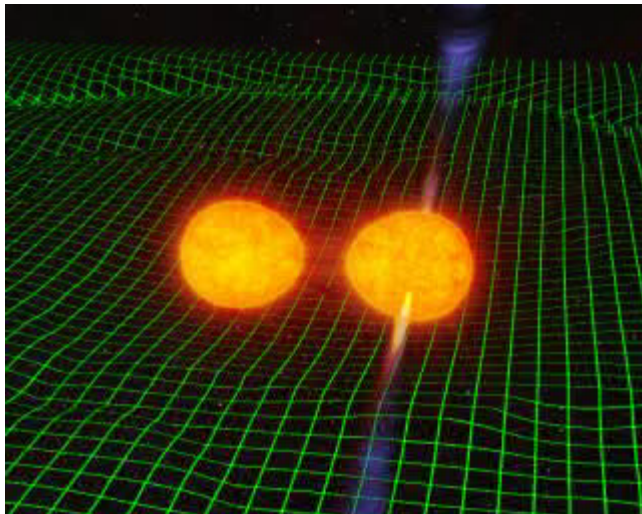
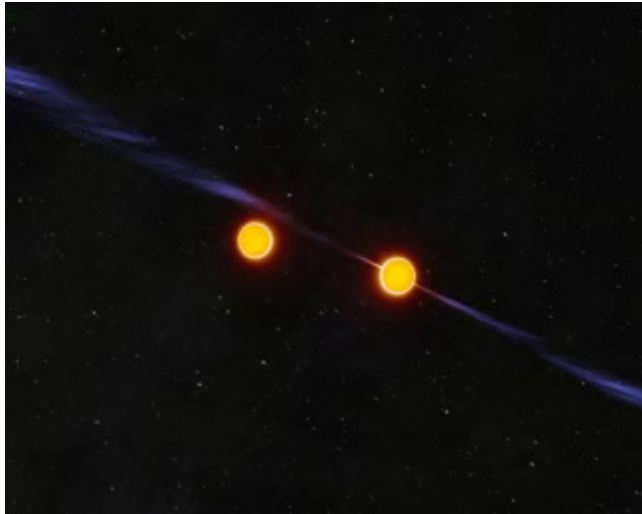


Hulse

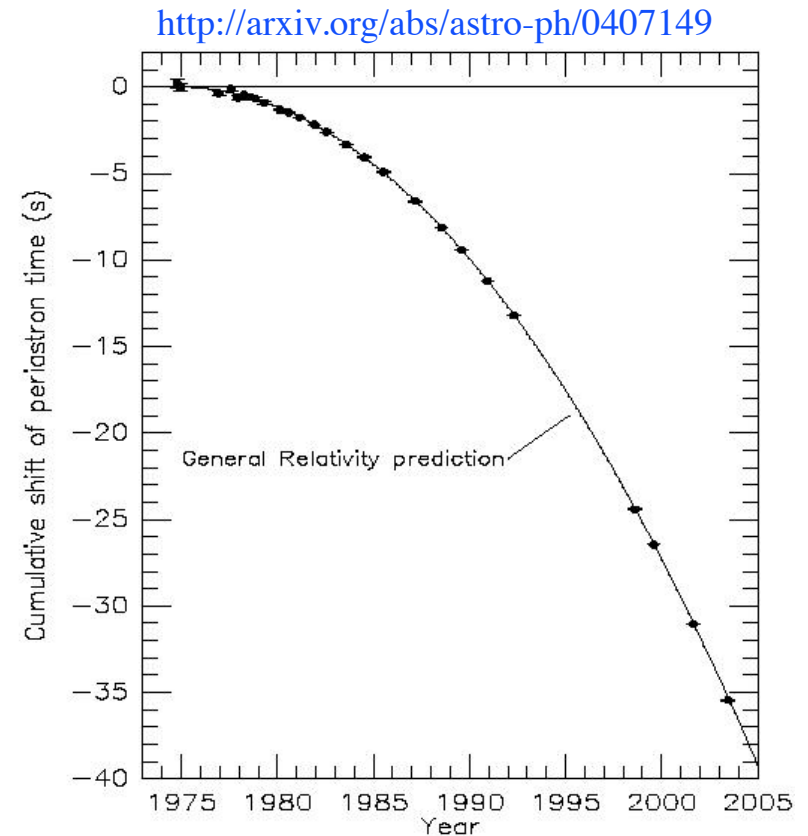


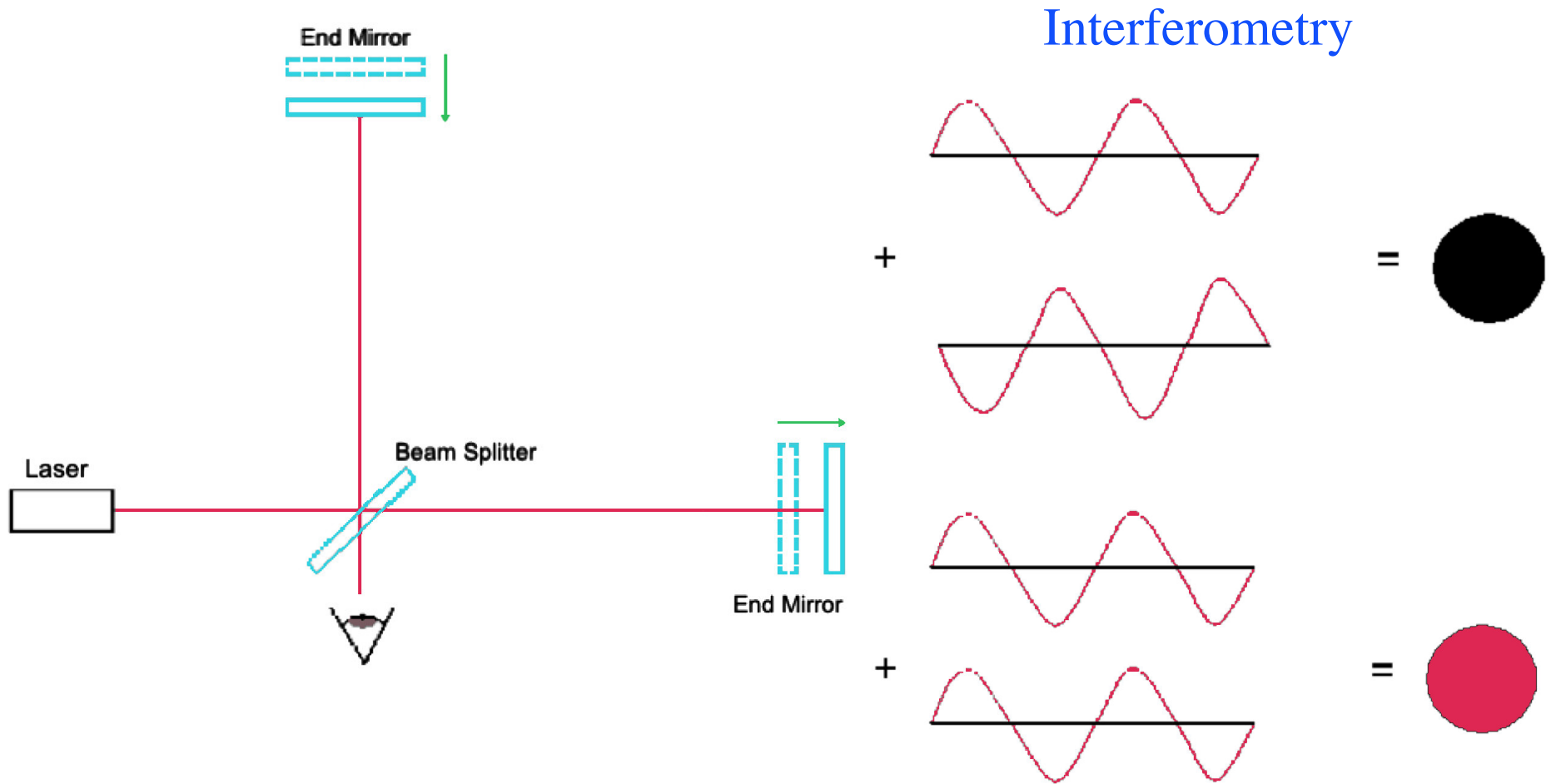
Taylor

In 1974, Russell Hulse and Joseph Taylor discover a new pulsar



[http://www.atnf.csiro.au/news/press/neutron\\_binary/](http://www.atnf.csiro.au/news/press/neutron_binary/)









# How Do We Detect Gravitational Waves?



Image Credit: LIGO Lab



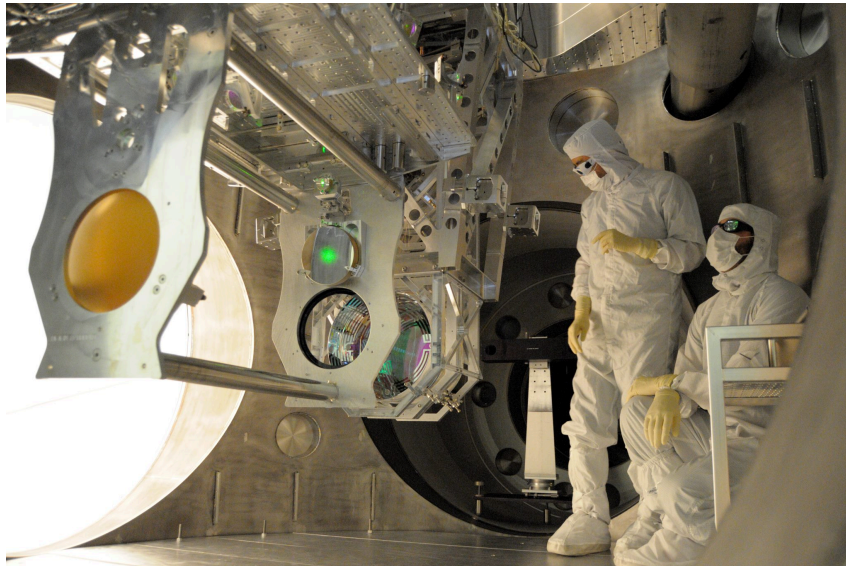
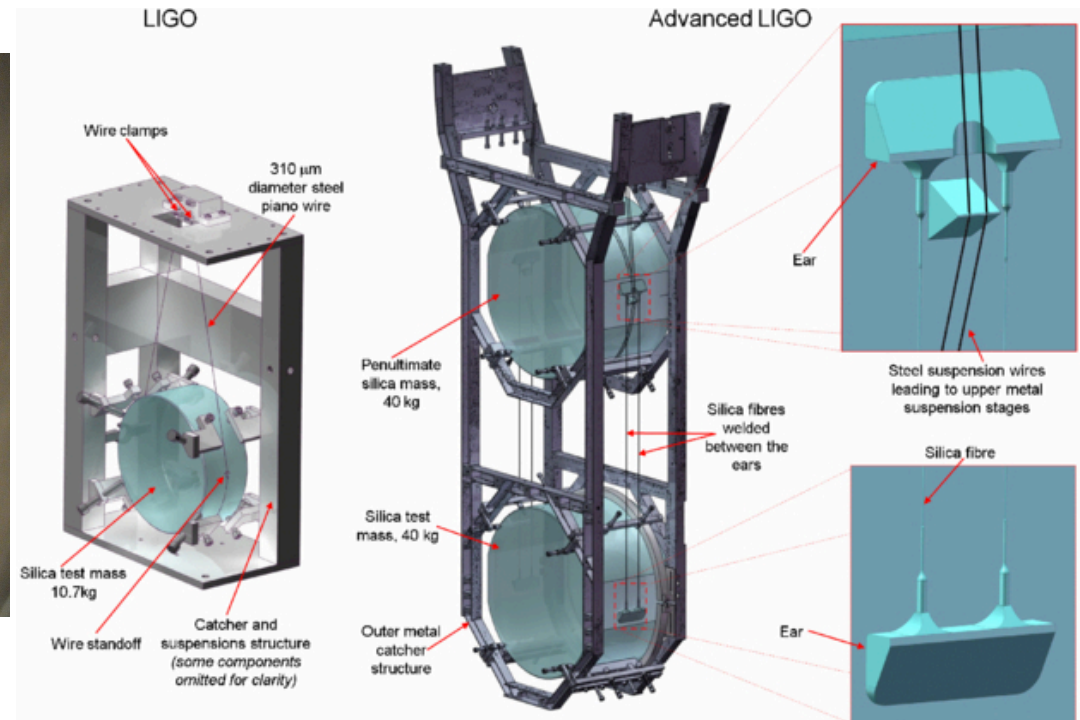


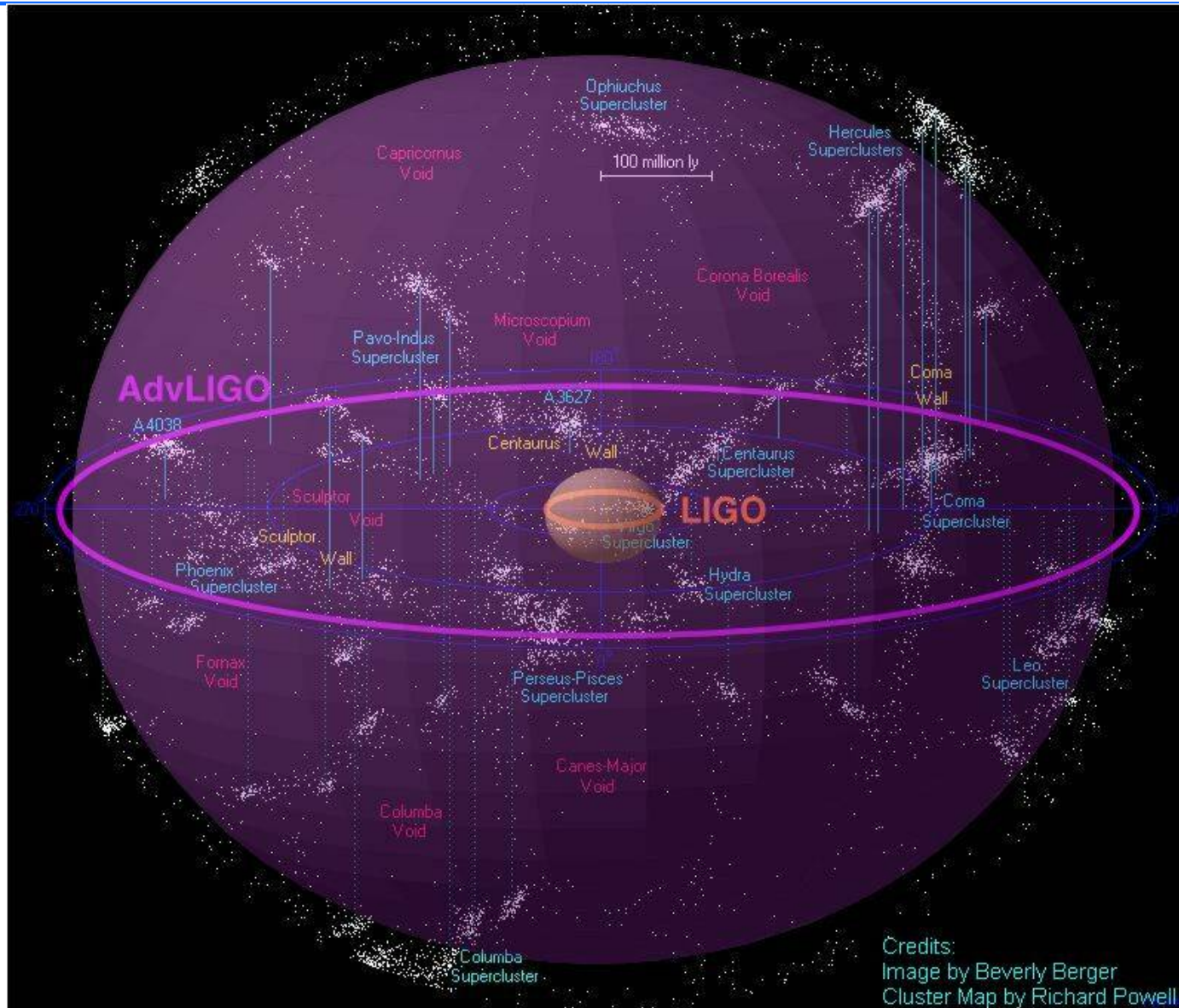
Image Credit: LIGO



Class. Quantum. Grav. 29 (2012) 035003

- Initial detectors (2002 – 2010)
- Upgrades
  - » Laser 4.5 W to 125 W
  - » Mirrors 25 cm diameter, 10.7 kg to 34 cm, 40 kg
  - » More sophisticated suspensions









# A Network of Gravitational Wave Detectors

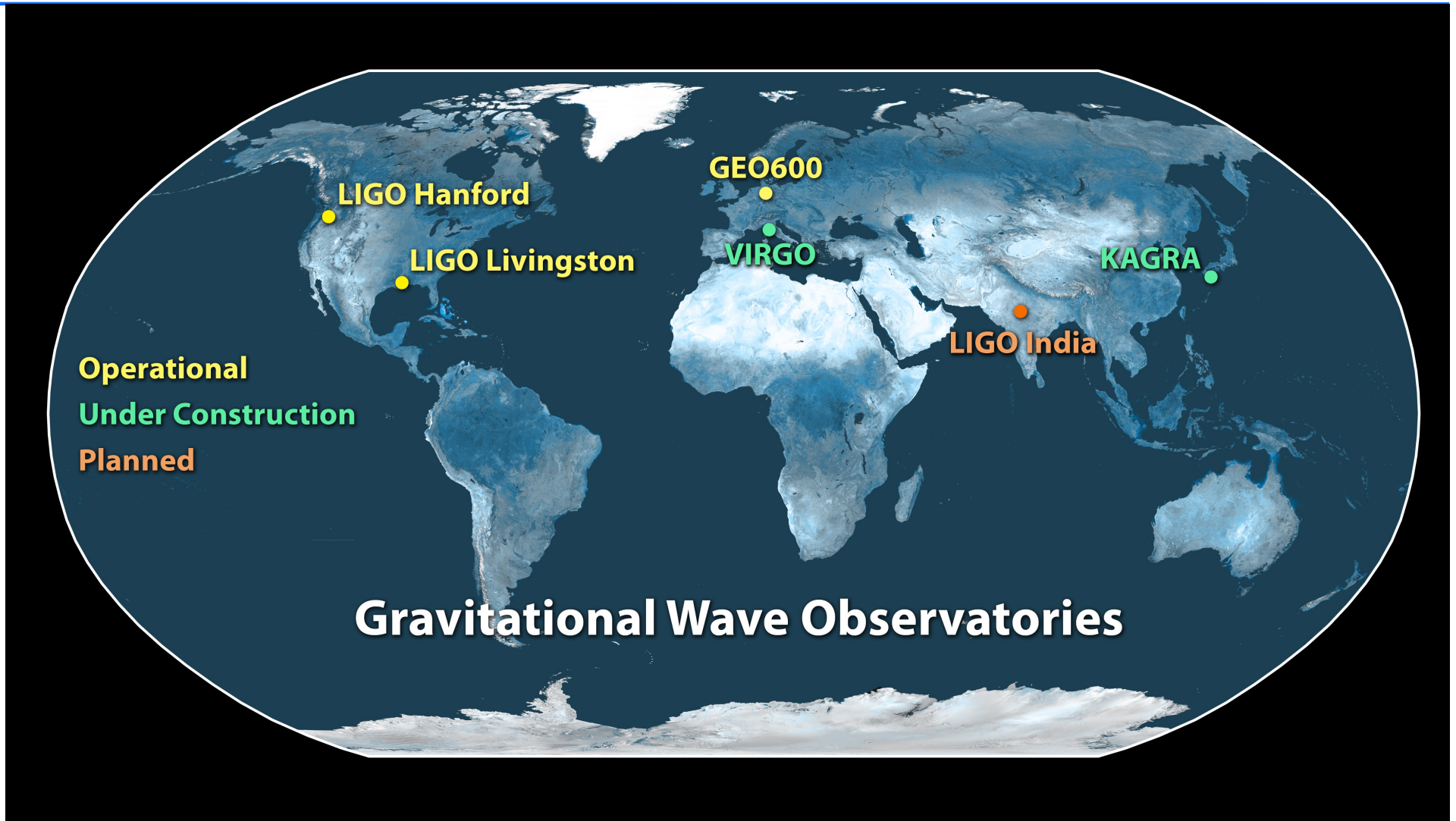


Image Credit: LIGO

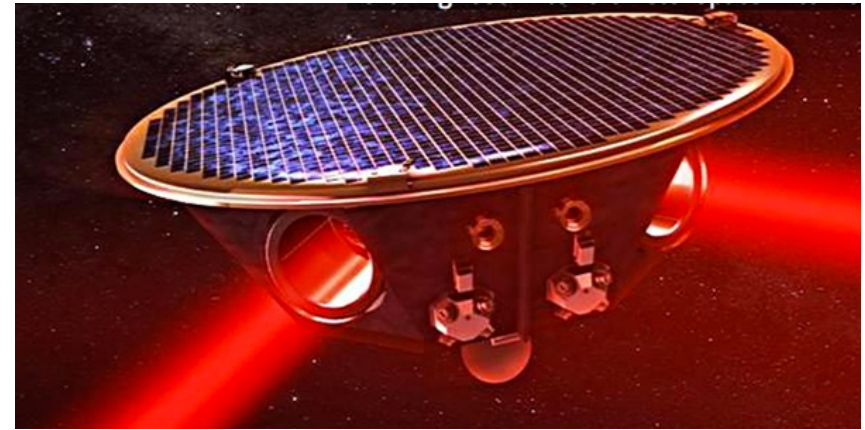
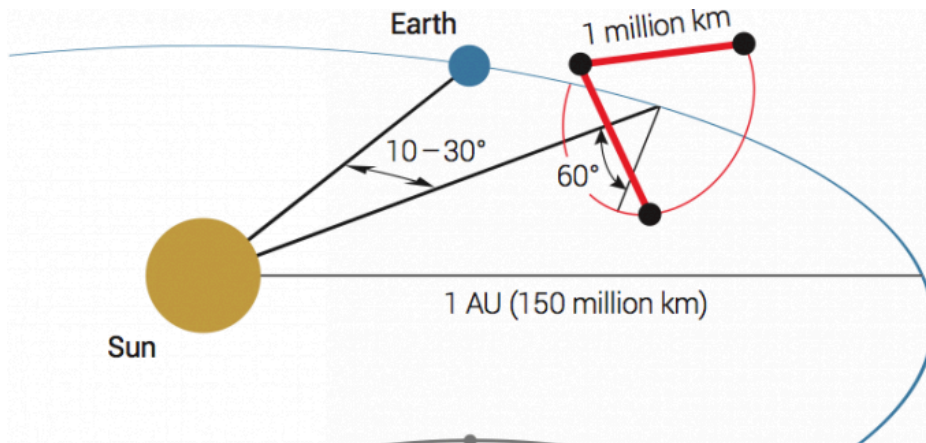


Image Credit: eLISA

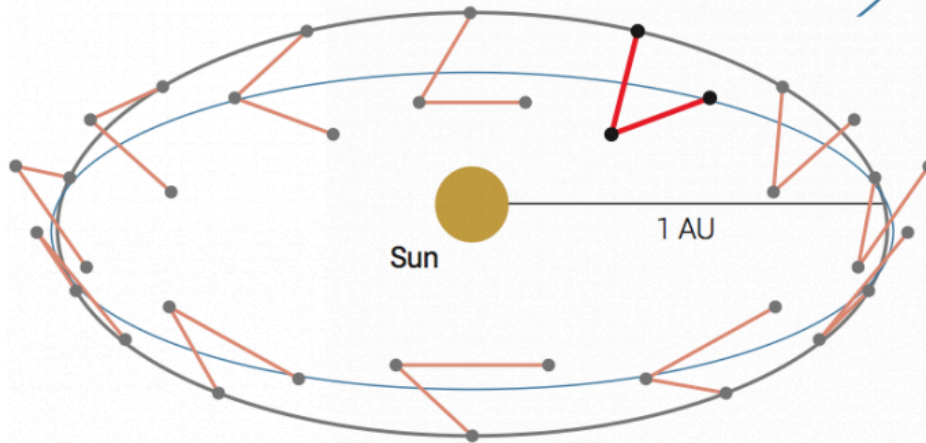
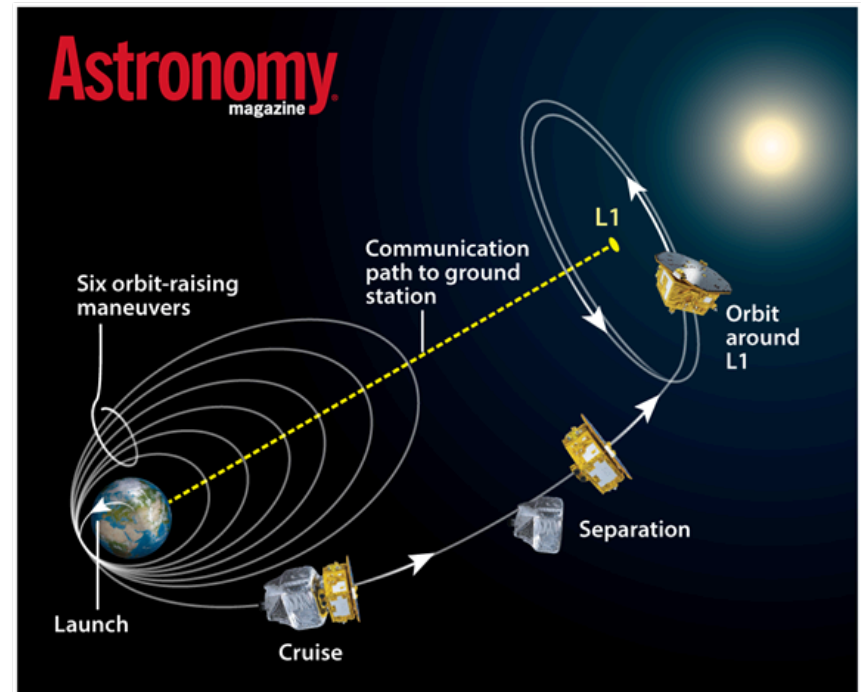


Image Credit: eLISA





# Laser Interferometer Space Antenna

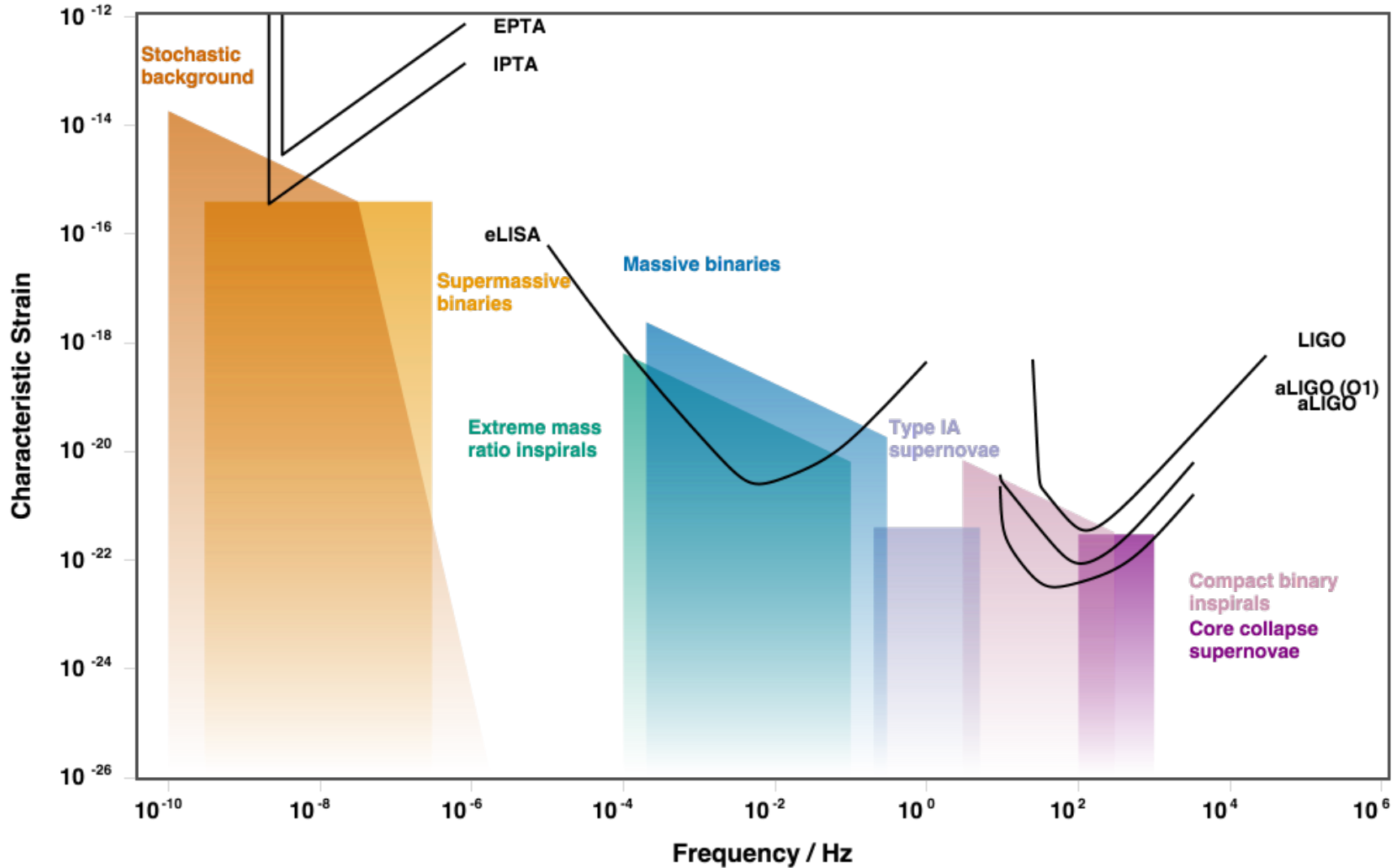
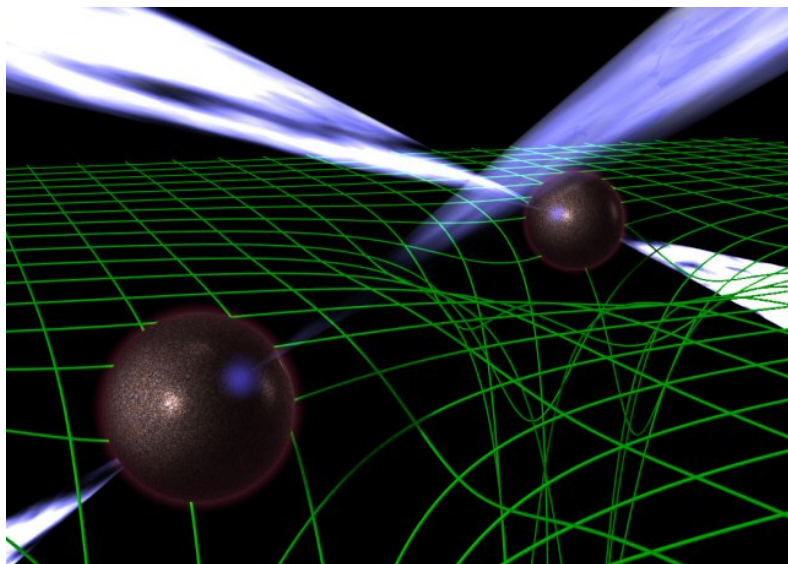


Image from <http://rhcole.com/apps/GWplotter>



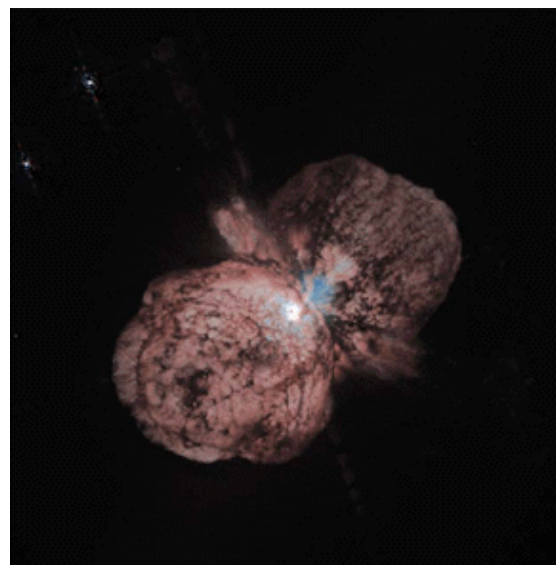


- Binary neutron star inspirals and binary black hole inspirals
- Spinning neutron stars
- Bursts from supernovae etc
- Stochastic background from indistinguishable sources and/or the creation of the universe



<http://www.jb.man.ac.uk/research/pulsar/doublepulsarcd/>

[http://hubblesite.org/gallery/album/entire\\_collection/pr1996023a/](http://hubblesite.org/gallery/album/entire_collection/pr1996023a/)



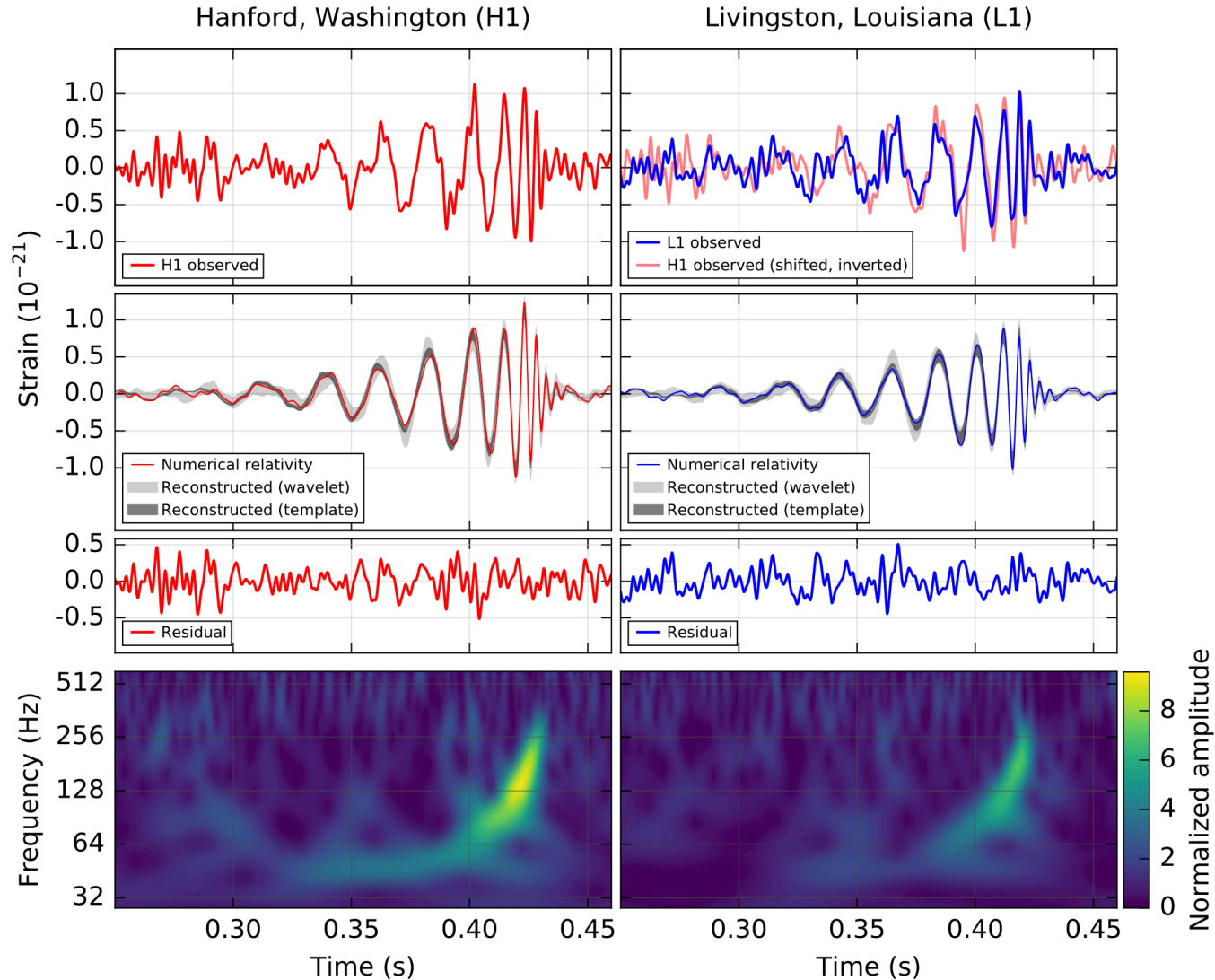


Image Credit: LIGO from B.P. Abbott et al Phys. Rev. Lett. **116** (2016) 061102



# GW150914: What did LIGO See?



- Binary Black Hole Inspiral
- $29 M_{\odot} + 36 M_{\odot} = 62 M_{\odot}$
- 1.3 billion light years away

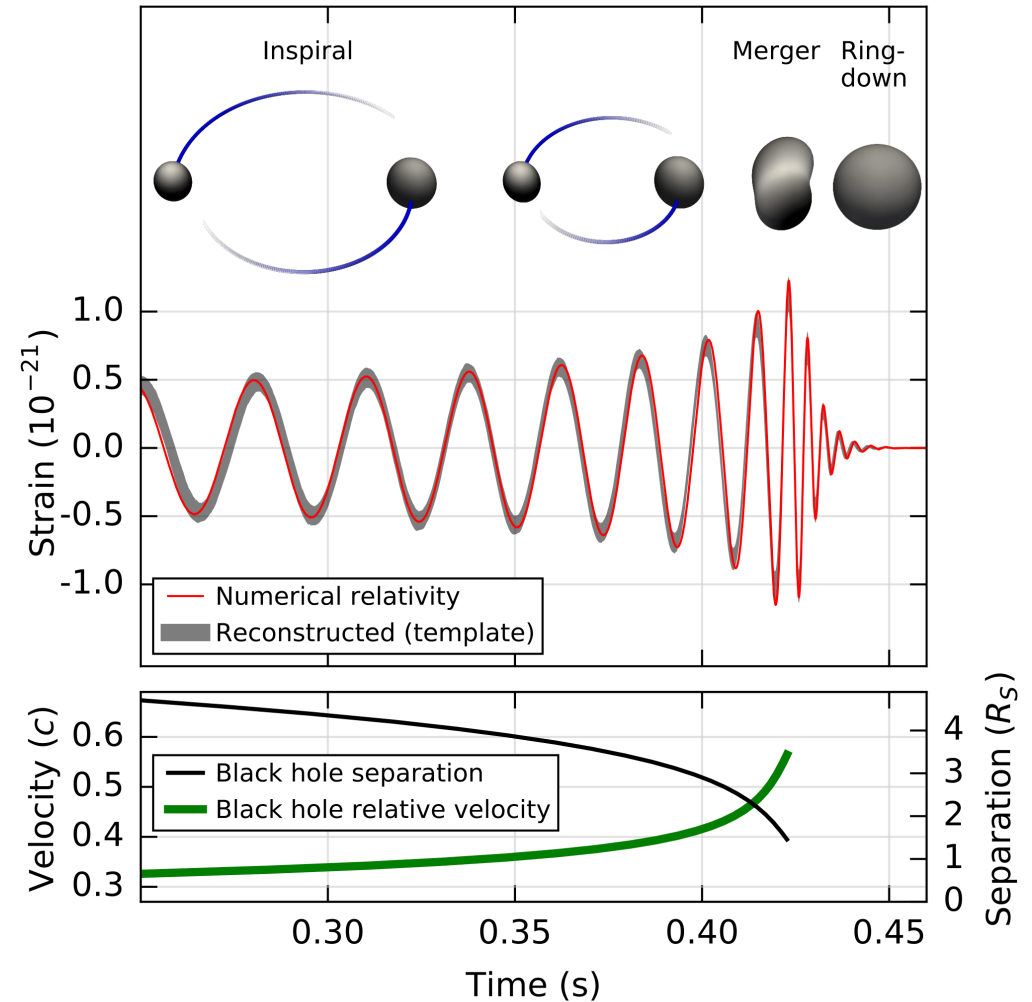
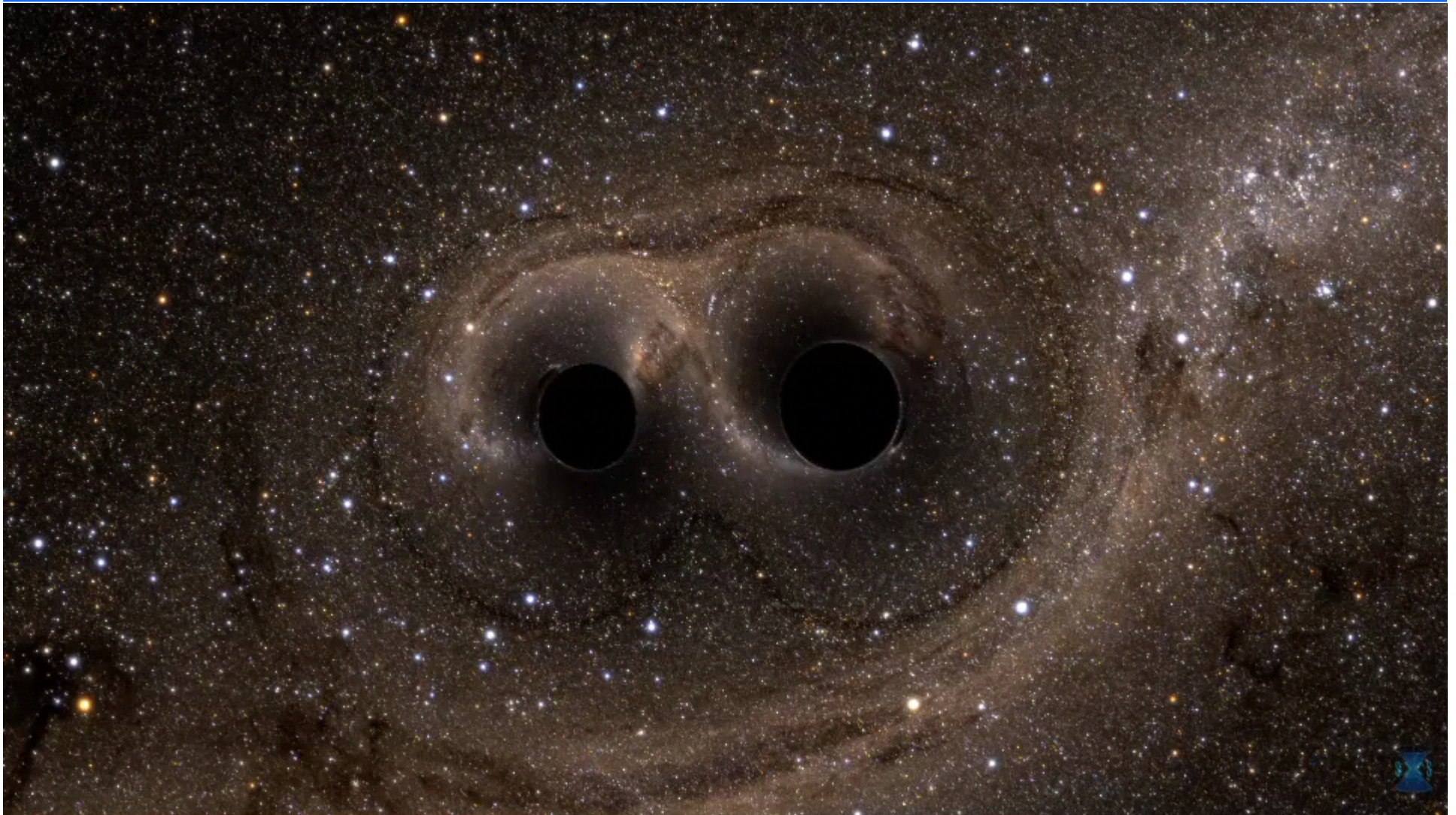


Image Credit: LIGO from B.P. Abbott et al Phys. Rev. Lett. **116** (2016) 061102





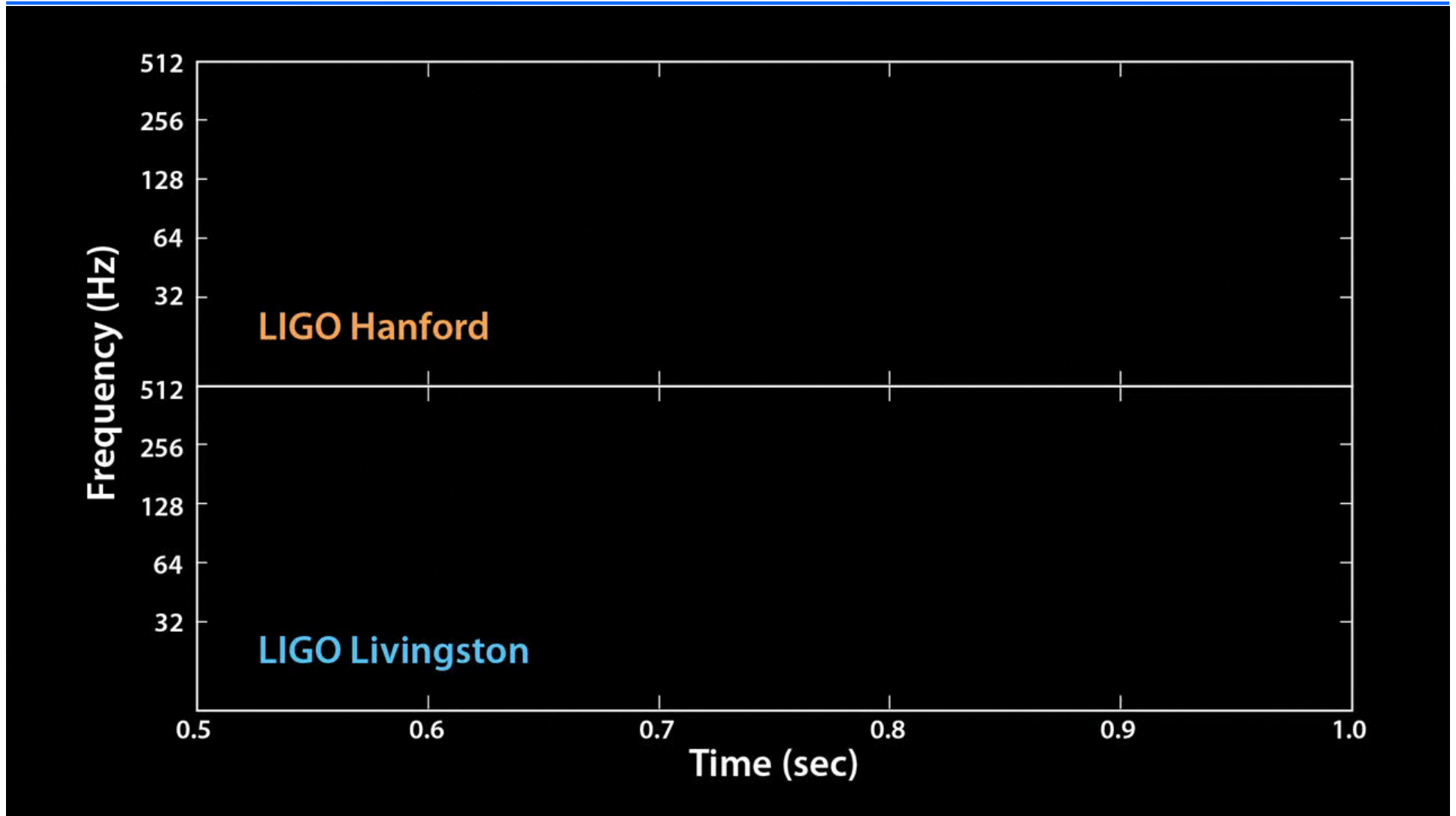
# GW150914: What did LIGO See?



Movie Credit: LIGO

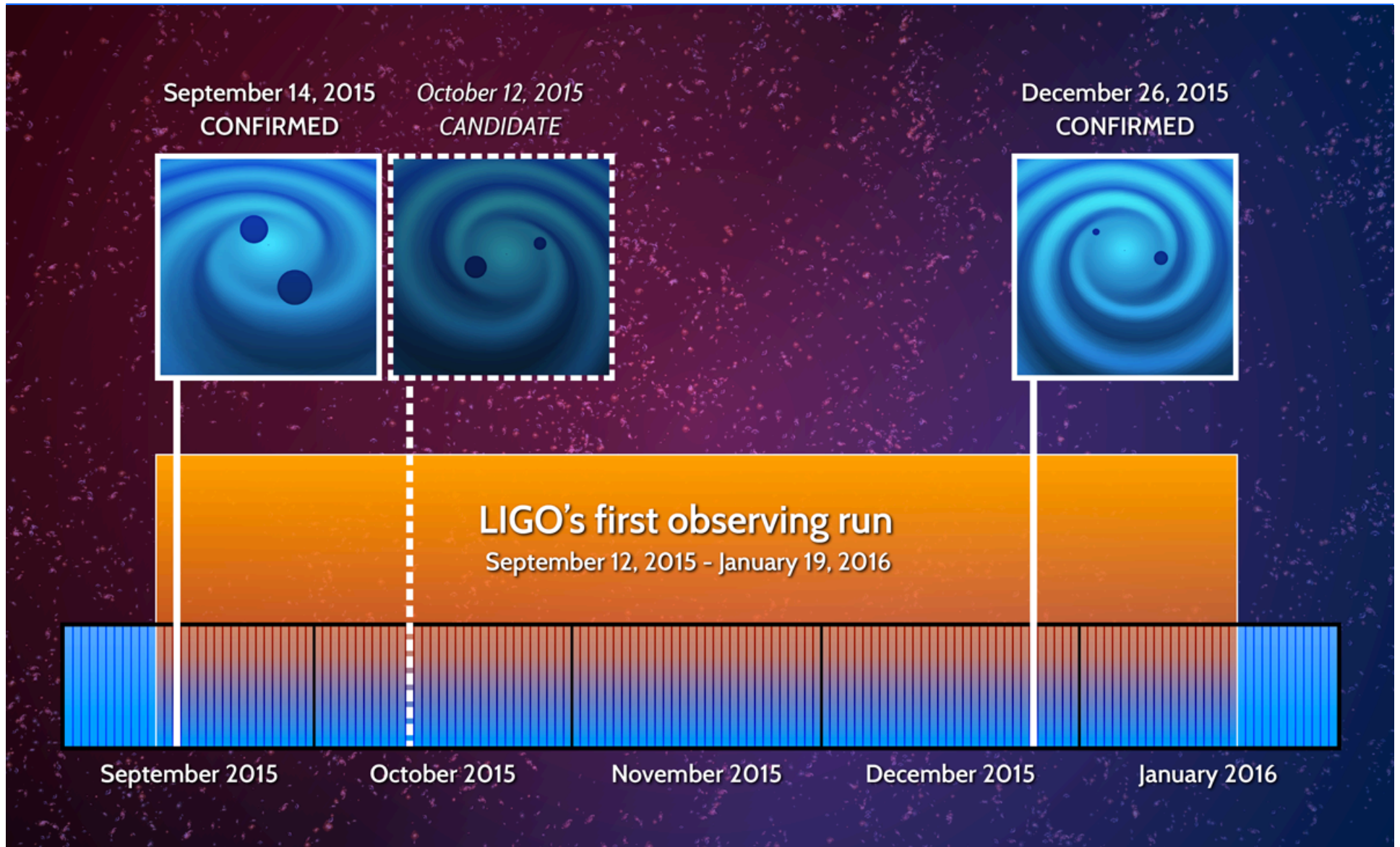


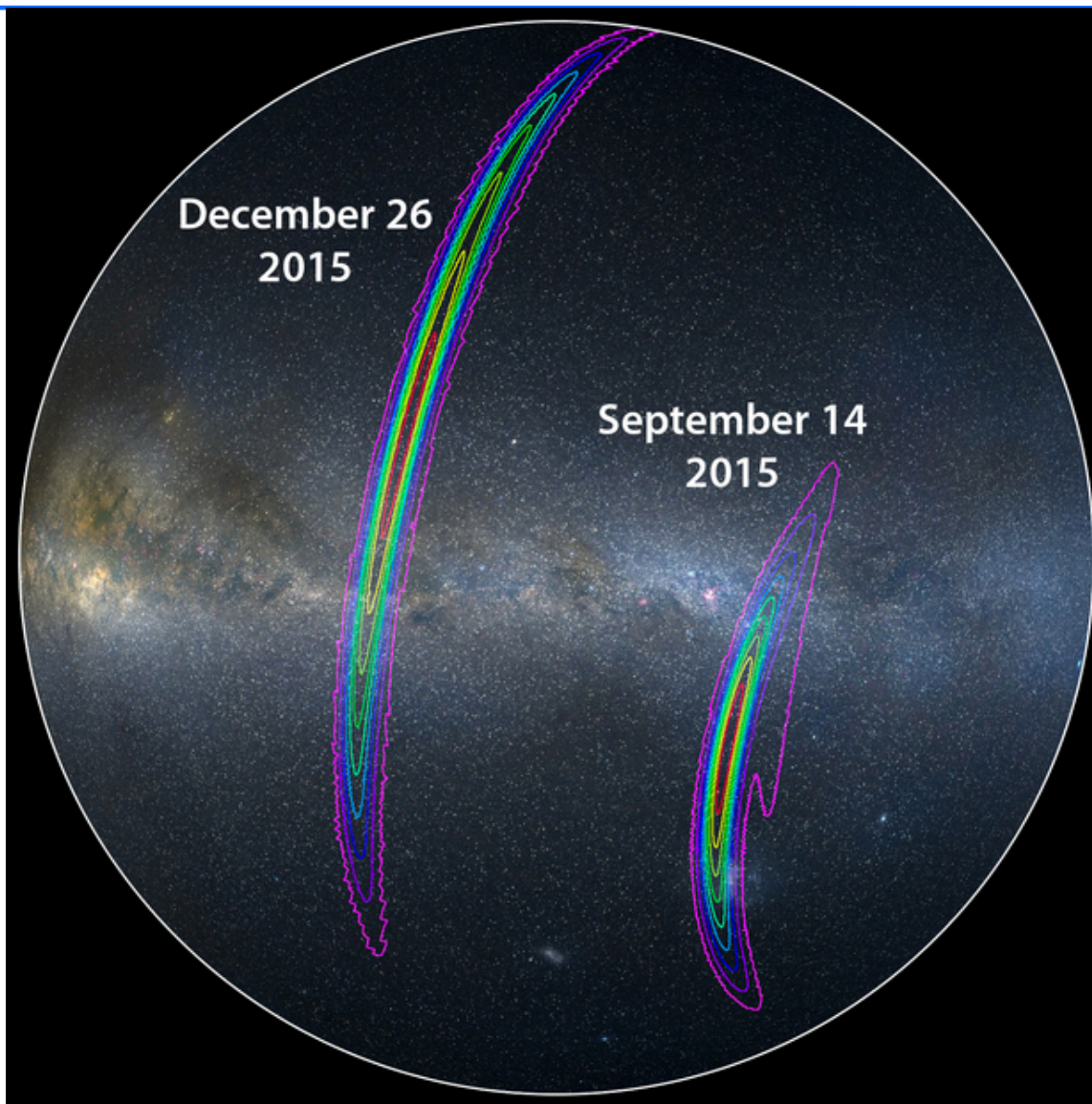
# The Music of the Spheres



Movie Credit: LIGO









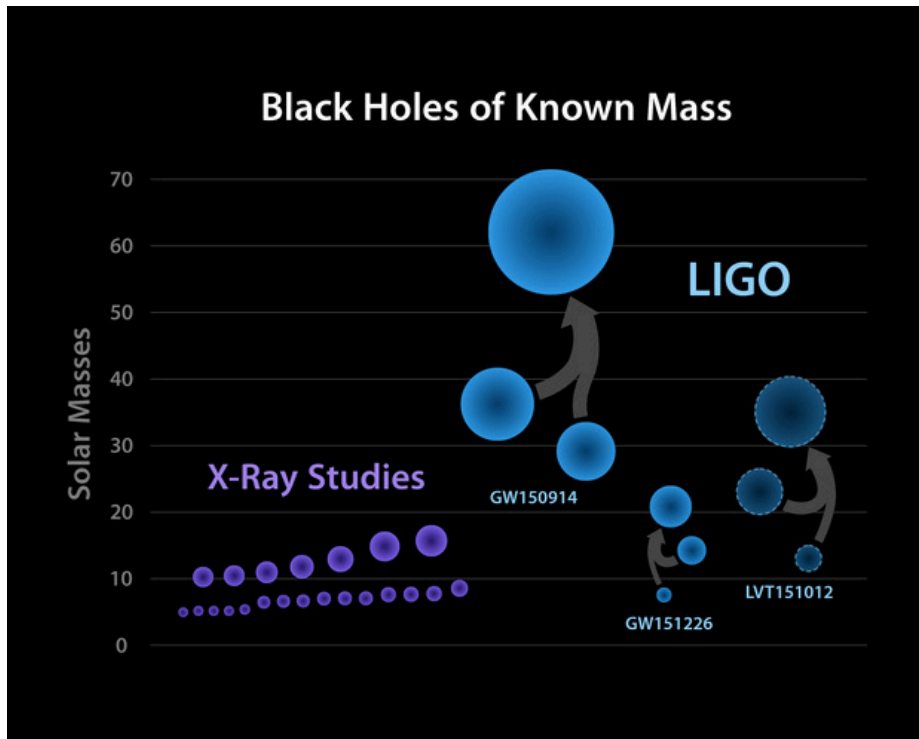


Image Credit: LIGO

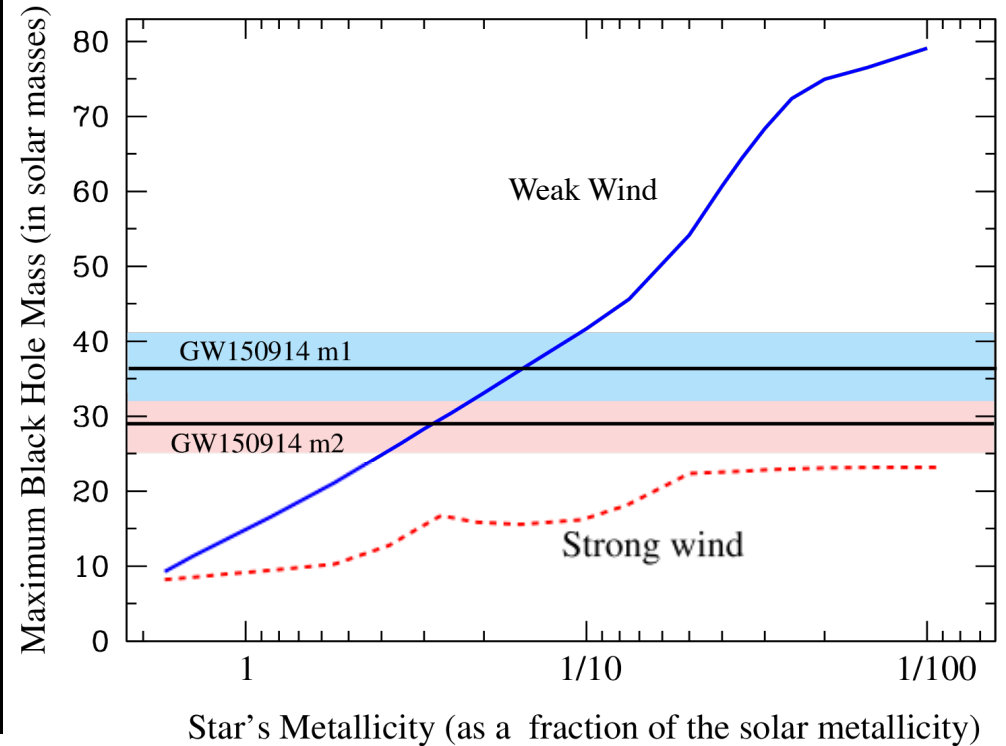
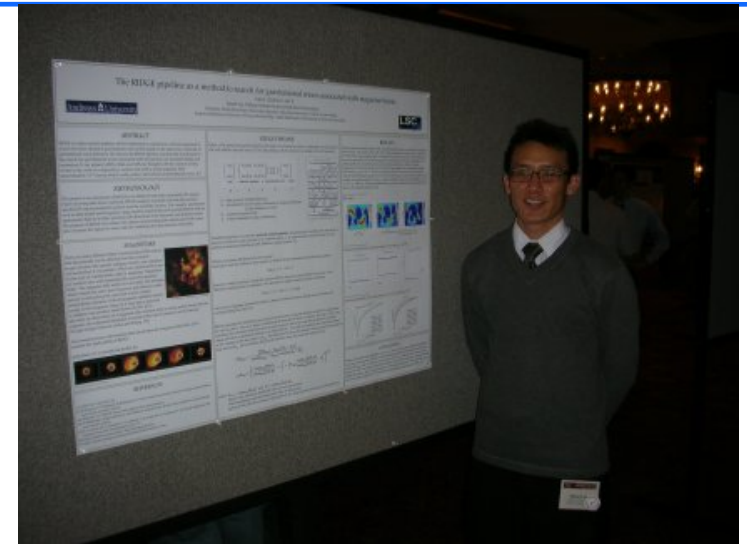


Image from <https://dcc.ligo.org/LIGO-P1500262>



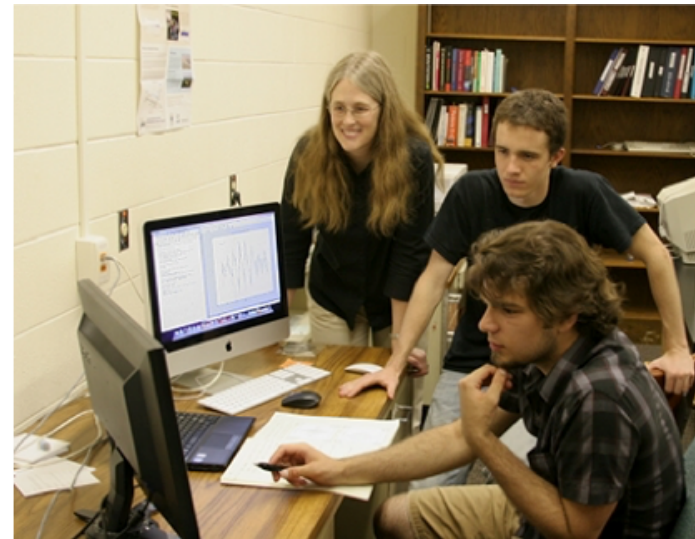
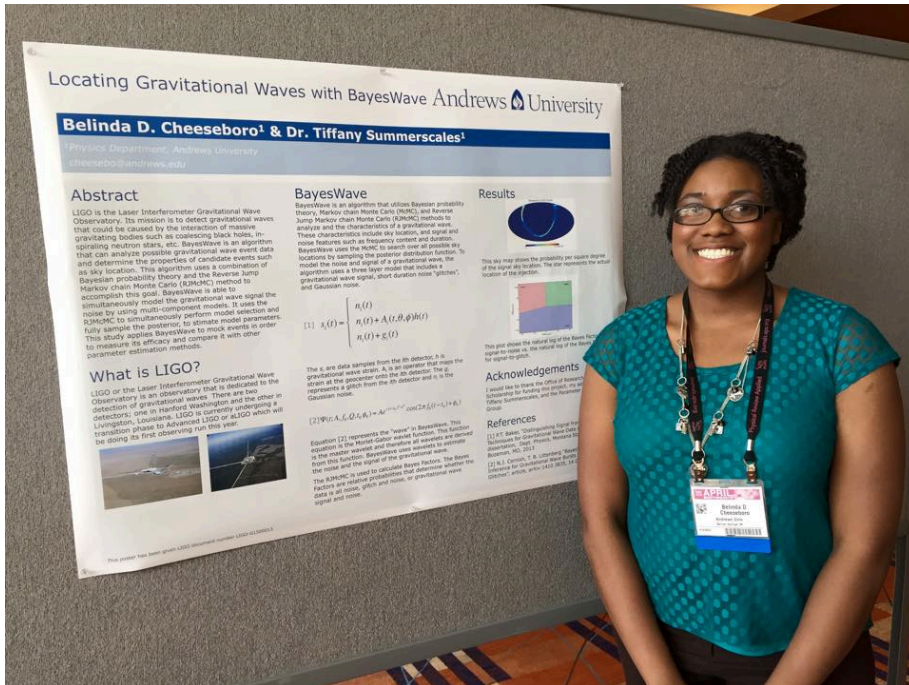
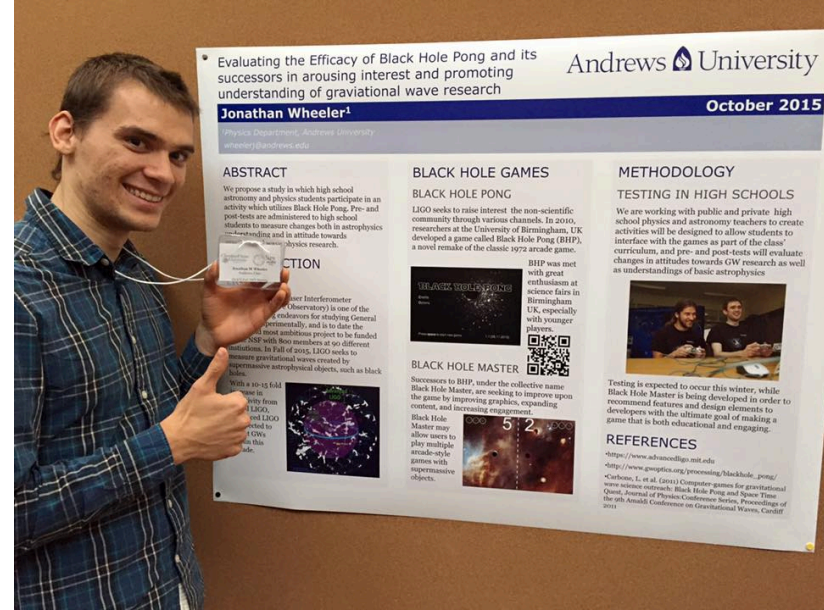
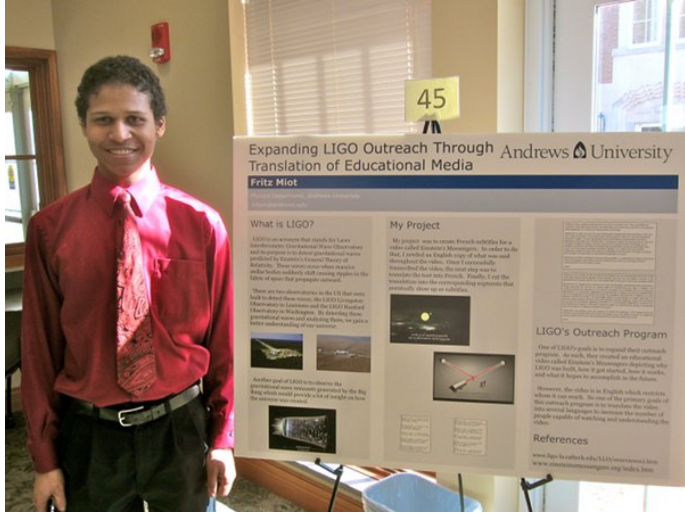
# LIGO @ Andrews



LIGO

Adventist Forum







# Learn More About It!



- Join the Search for Gravitational Waves
  - » Einstein@Home <http://einstein.phys.uwm.edu/>
- Help Improve the Detectors
  - » Zooniverse Gravity Spy  
<https://www.zooniverse.org/projects/zooniverse/gravity-spy/>
- Learn More about LIGO
  - » LIGO website <http://www.ligo.org>
  - » Einstein's Unfinished Symphony by Marcia Bartusiak