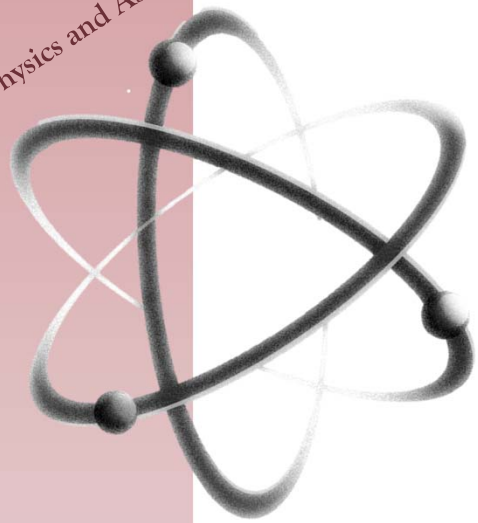
Department of Physics and Astronomy



University of South Carolina

Gravitational Waves

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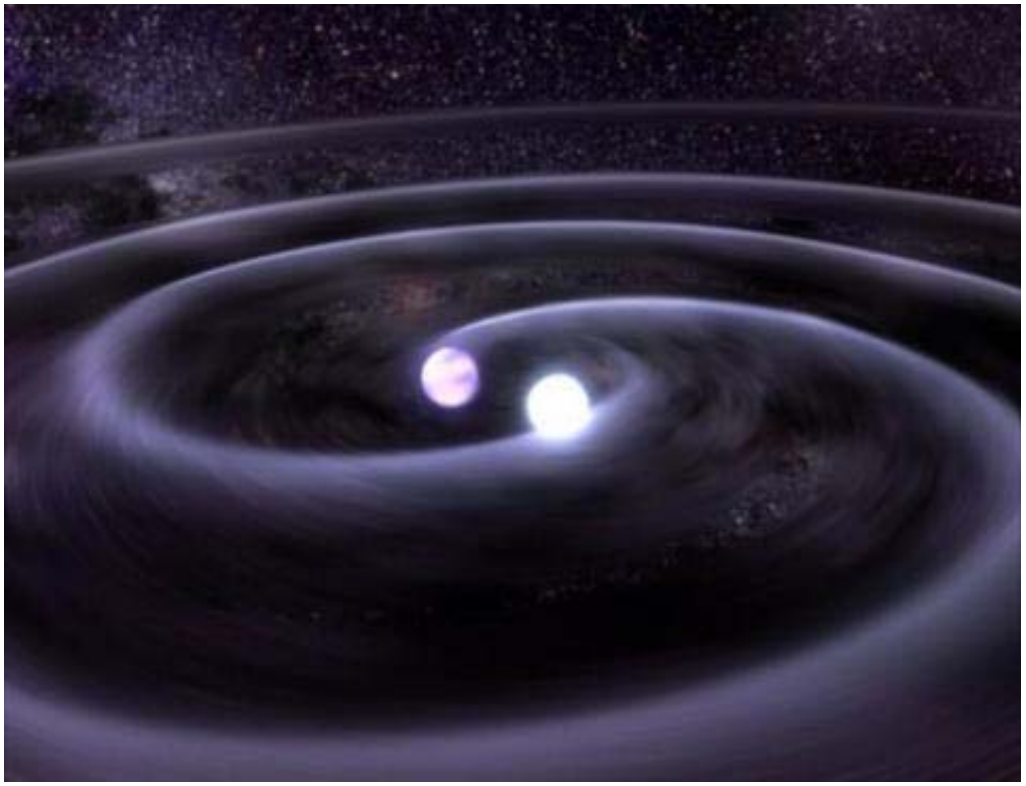
Contents

What is the “Gravitational Waves”?

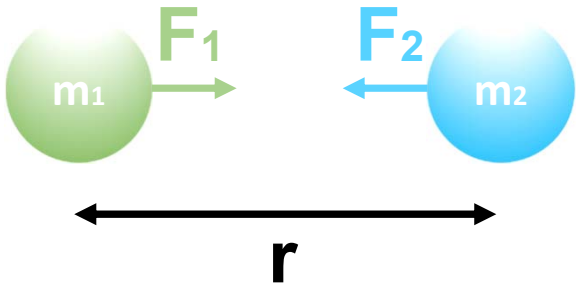


The Novel Prize in Physics 2017

Gravitational waves are waves that are carried out at the speed of light by fluctuating curvature of the gravitational field in space-time by mass.

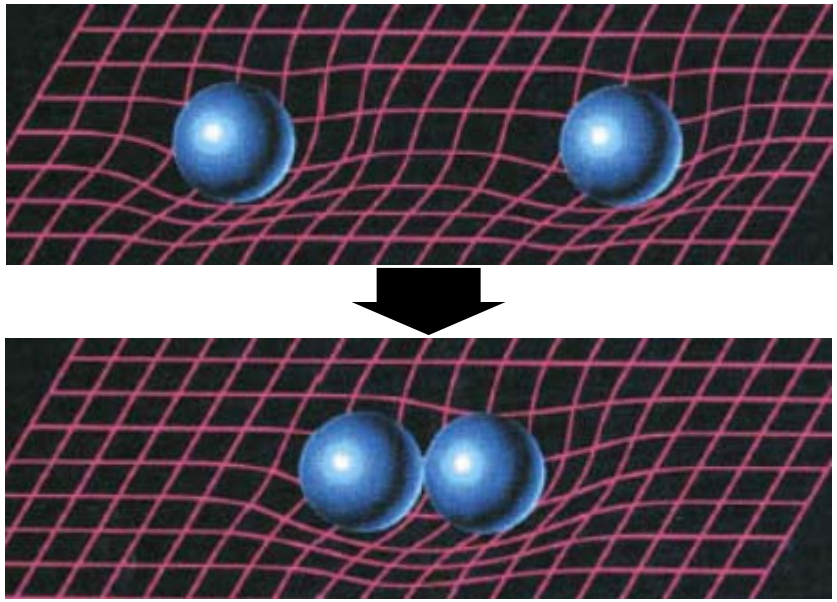
Gravitation Force

Newton's gravitation force perspective



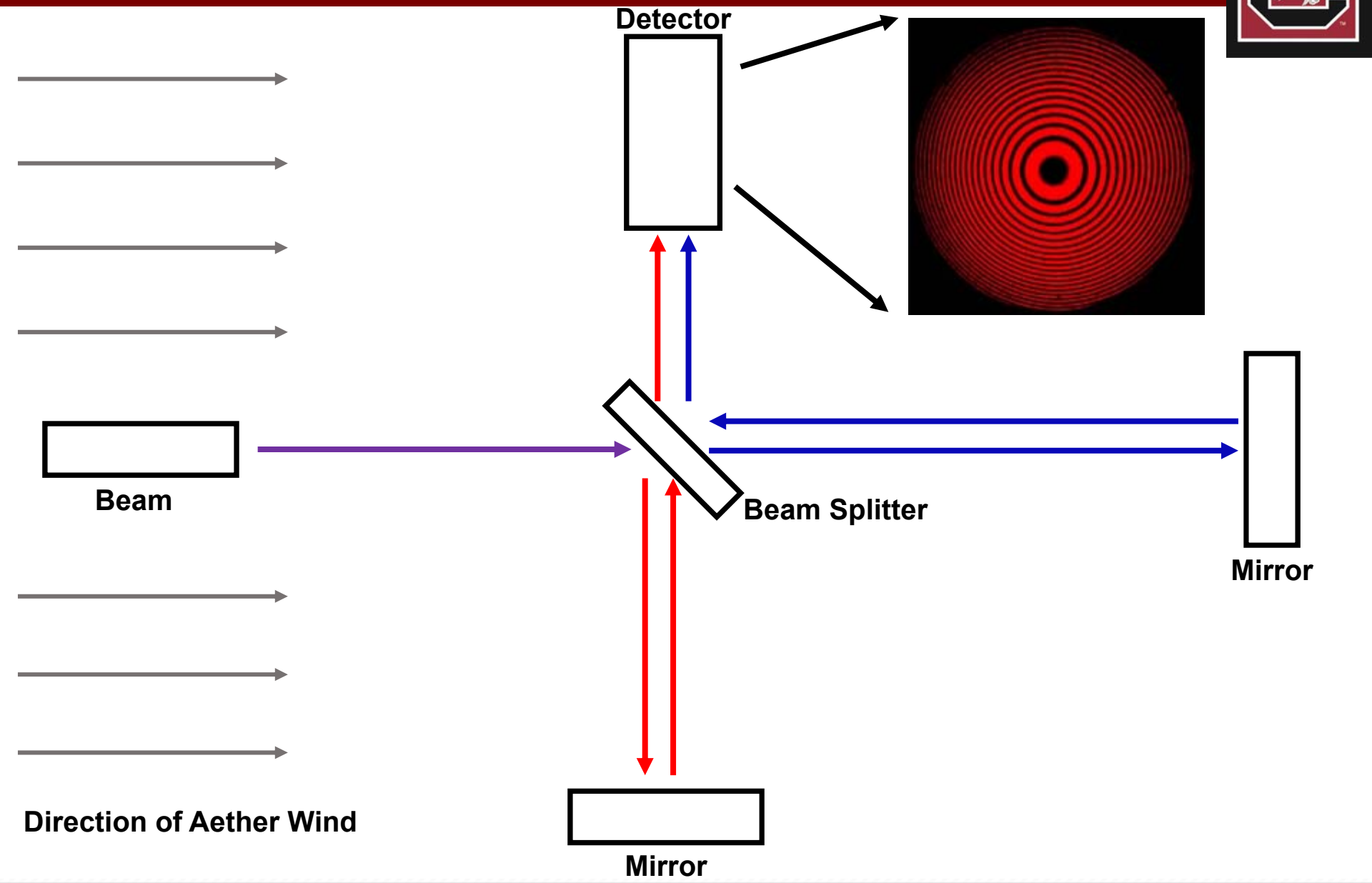
$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

Einstein's gravitation field perspective

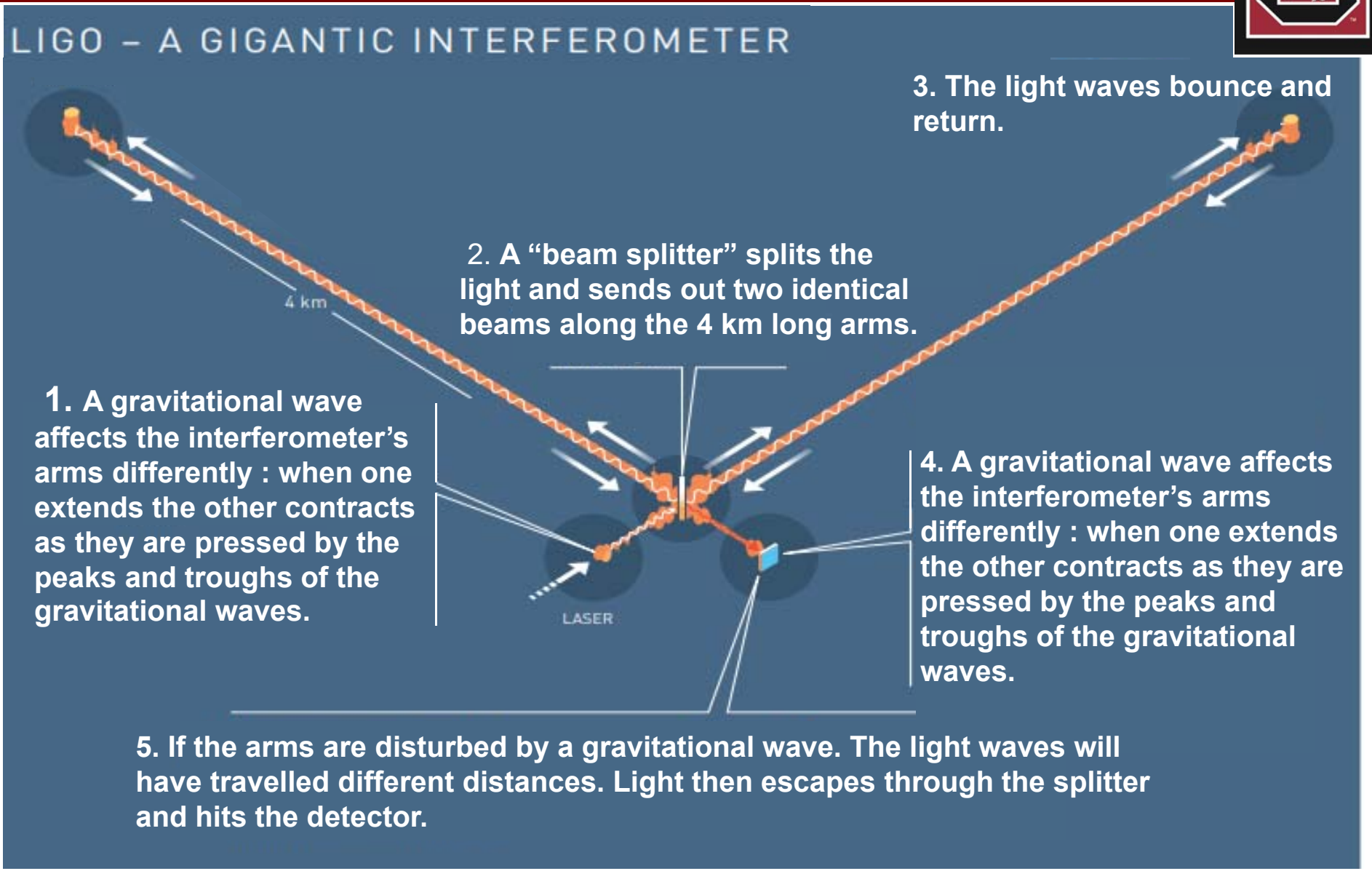


$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = \frac{8\pi G}{c^4}T_{\mu\nu}$$

Michelson Interferometer

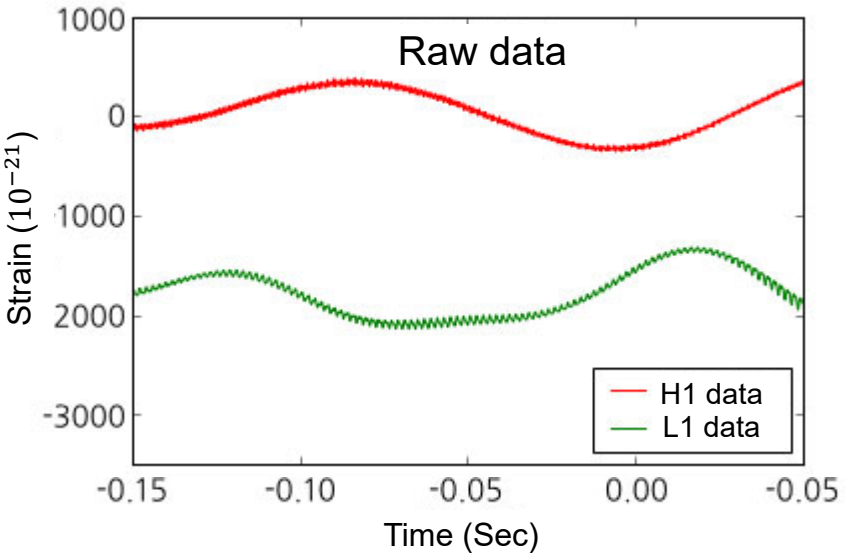


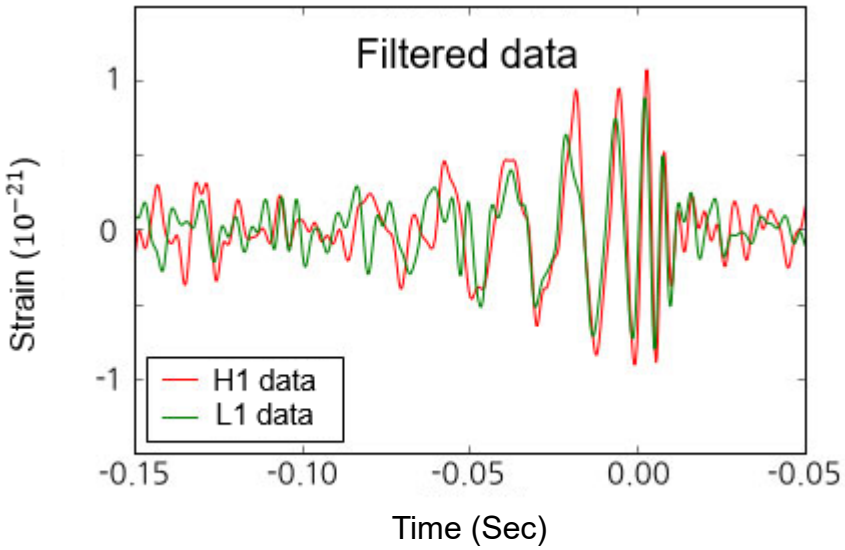
LIGO Experiment



Results & Analysis

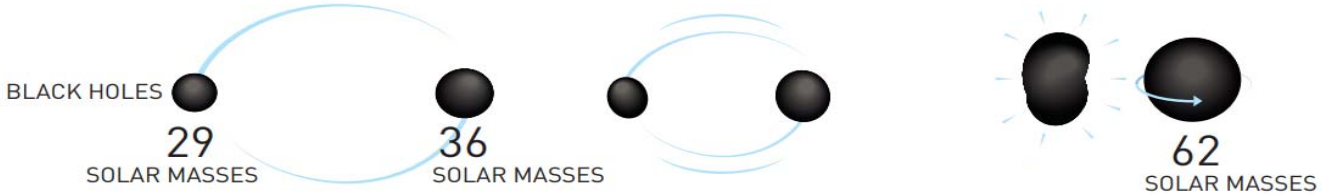
$$Strain = \frac{Distance\ difference}{LIGO\ length}\ (10^{-21})$$

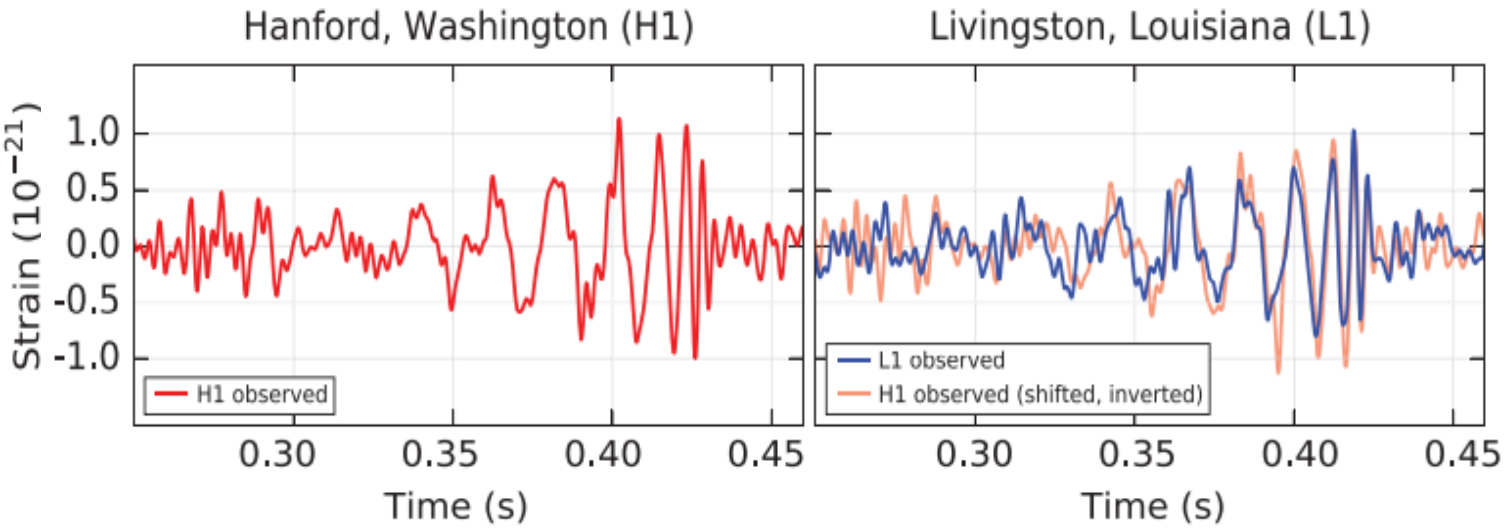




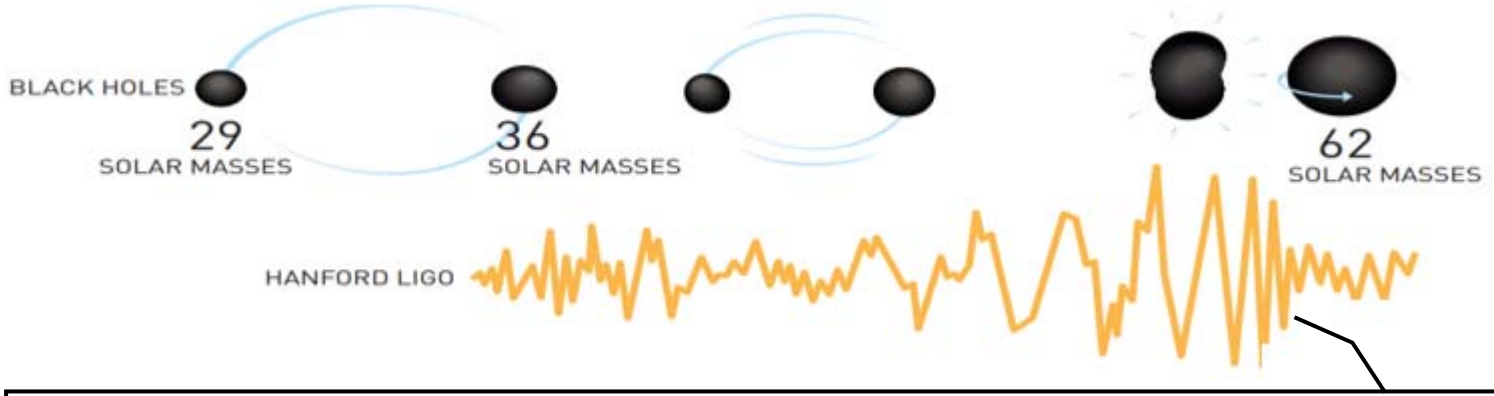
Hanford, Washington (H1)
Livingston, Louisiana (L1)

Results & Analysis

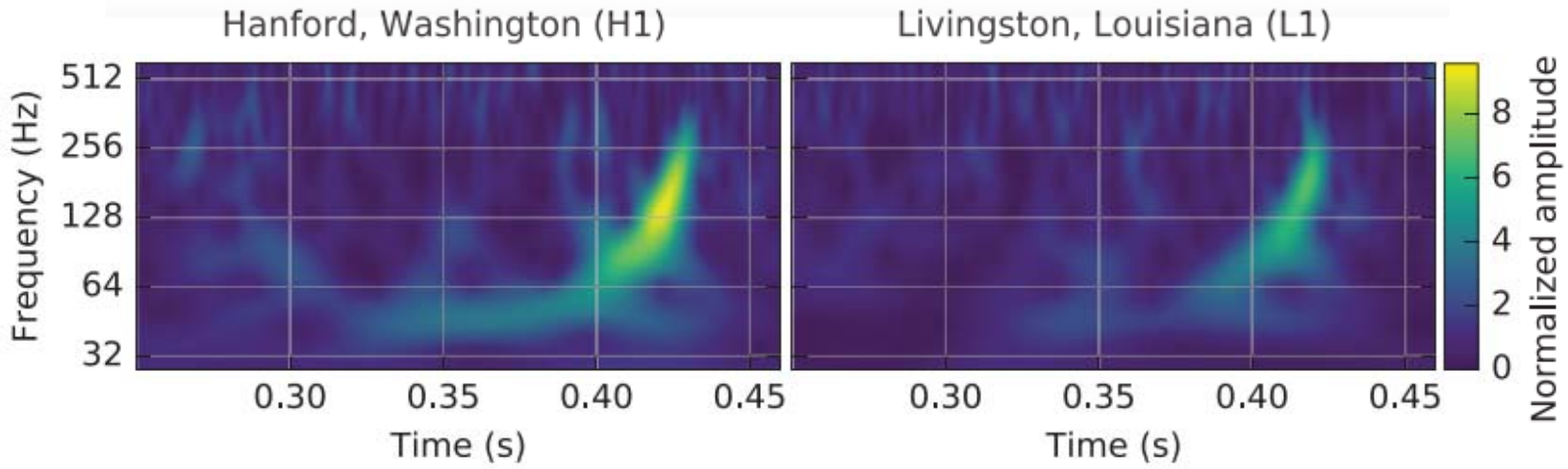




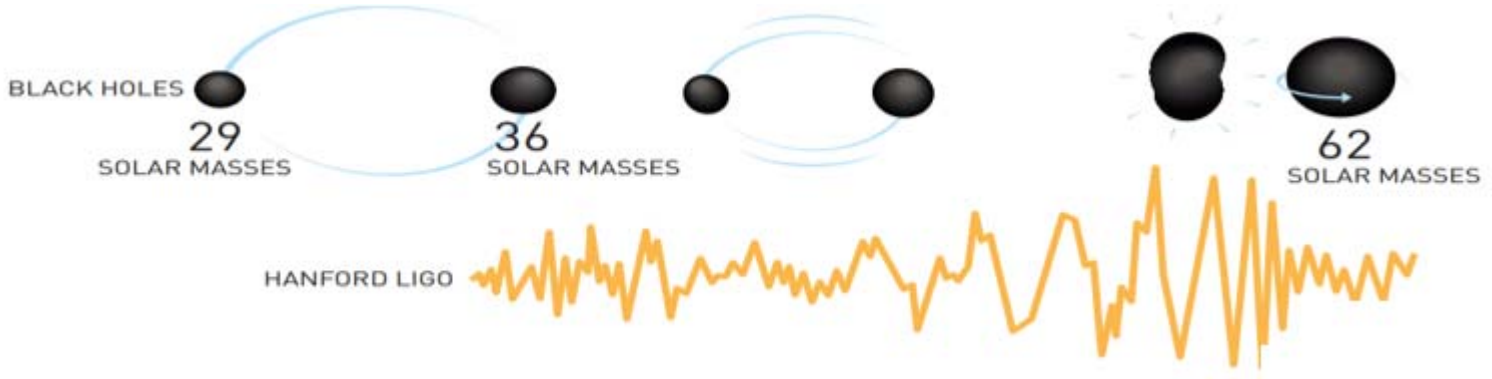
Results & Analysis



Chirp mass : When two black holes are coalescing with each other by orbital evolving, the loss of energy is occurred to as a gravitational wave, and this occurred energy loss determines chirp mass.



Results & Analysis



$$\mu = \frac{(m_1 m_2)^{\frac{3}{5}}}{(m_1+m_2)^{\frac{1}{5}}} = \frac{C^3}{G}\left[\frac{5}{96}\pi^{\frac{-8}{3}} f^{\frac{-11}{3}} \dot{f}\right]^{\frac{3}{5}}$$

$\mu : Chrip\ mass\ , m_1 = m_2 = Mass\ of\ blackhole, f : Observed\ frequency,$
$\dot{f} : Observed\ frequency\ time\ derivative, G : Gravitational\ constant, C : Speed\ of\ light$

Primary black hole mass	$36^{+5}_{-4}M$
Secondary black hole mass	$29^{+4}_{-4}M$
Final black hole mass	$62^{+4}_{-4}M$

Reference

“Novel Prize” website

Dissertation named “Observation of Gravitational Waves from a Binary Black Hole Merger”

LOGO website