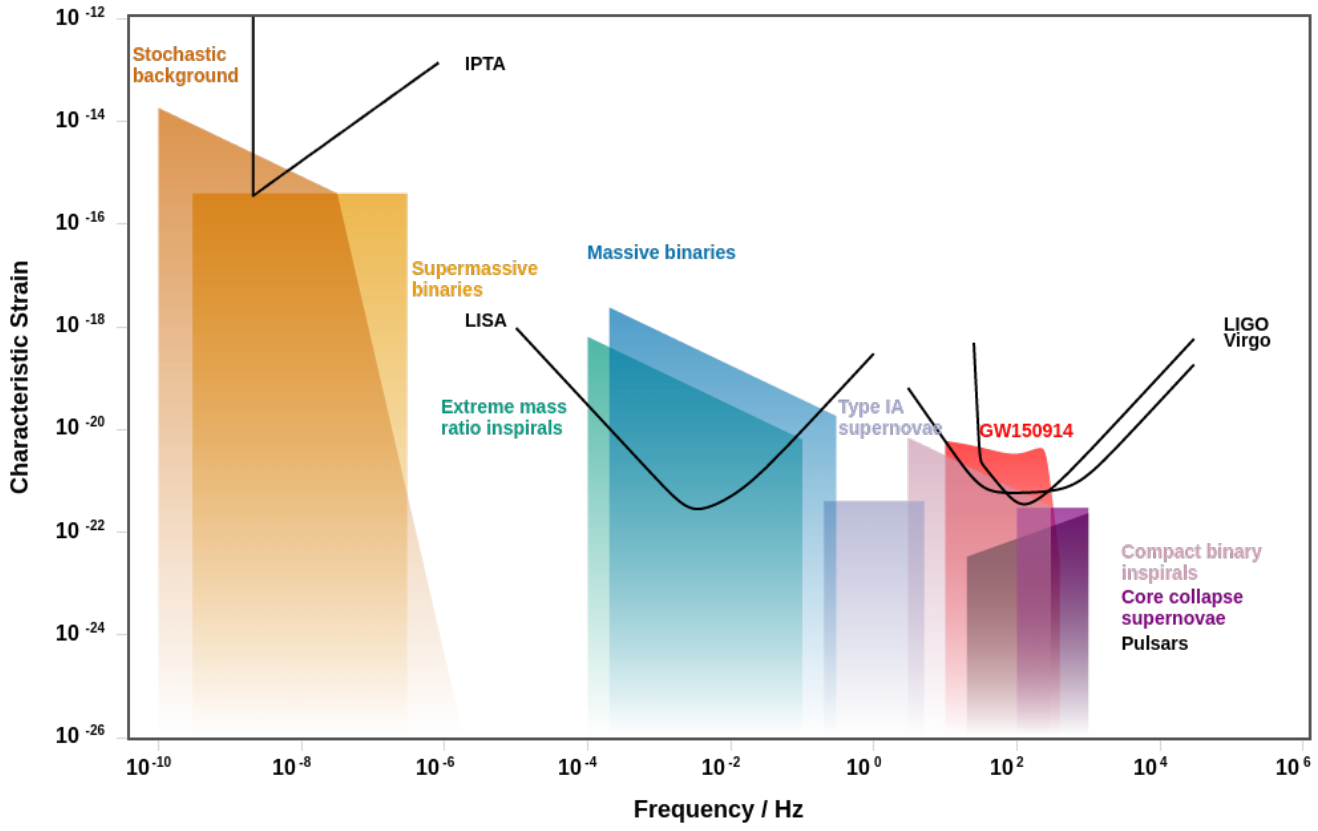
Lecture 29 : Gravitational Radiation

This lecture is about the recent detections of gravitational waves. Just as Maxwell's Theory of Electromagnetism predicted the existence of transverse electromagnetic waves, Einstein's General Theory of Relativity predicted the existence of "Gravitational Radiation". Although this should have been regarded as a 'straightforward conclusion' of any 'relativistic theory of gravitation', serious doubts about their existence persisted for more than forty years, with Einstein himself being one of the 'doubters'. These doubts were finally laid to rest by a series of remarkable papers published in the 1950s and early 1960s. The first observational evidence for gravitational radiation came in the late 1970s. The shrinking of the orbit of the Hulse-Taylor binary pulsar agreed precisely with the prediction from General Relativity. Meanwhile, heroic efforts were underway to build a Laser Interferometer that would actually detect gravitational waves. This was an incredible symbiosis between physics, engineering and technology. On 14 September 2015, almost exactly a hundred years after Einstein's paper, the laser interferometer detected a burst of gravitational waves from two coalescing black holes.



The above figure is a representation of the sensitivy regimes gravitational wave detectors and sources [Credit : Christopher Moore, Robert Cole and Christopher Berry]. Christopher Berry, a gravitational wave astronomer of CIERA and the LIGO scientific collaboration, maintains a lovely blog (https://cplberry.com/blog/) where he explains the above curve and all things related to gravitational wave astronomy.

18 November 2022

Astronomy & Astrophysics : An Introductory Survey

A lecture series by Prof. G. Srinivasan

A 'Golden Jubilee Celebration' Event of the Astronomical Society of India

Lecture 29 : Gravitational Radiation

[Supplementary Material : Dr. Sushan Konar]

Resource Material

1. ***Text Books***

   (a) J. Weber, 2004, **General Relativity and Gravitational Waves**, Dover

   (b) M. Maggiore, 2007, **Gravitational Waves : Theory and Experiments**, Oxford University Press

   (c) S. Dhurandhar & S. Mitra, 2022, **General Relativity and Gravitational Waves**, Springer

2. *Popular / Semi-Popular / Technical Articles*

   (a) D. Lincoln & A. Stuver, 2016, Am. J. Phys., 54, 398
   Ripples in Reality

   (b) H. Mathur, 2017, Am. J. Phys., 85, 676
   An analysis of the LIGO discovery based on introductory physics

   (c) D. Castelvecchi, Scientific American, April, 2018
   Here Come the Waves

   (d) M. C. Miller & N. Yunes, 2019, Nature, 568, 469
   The new frontier of gravitational waves

   (e) M. Bailes et al., 2021, Nature Reviews Physics, 03, 344
   Gravitational-wave physics and astronomy in the 2020s and 2030s

3. ***Lectures by Kip Thorne***

   (a) A Century of Relativity

   (b) Nobel Lecture

   (c) Exploring the Universe with Gravitational Waves

   (d) The Warped Side of the Universe

4. ***Gravitational Wave Observatories.. (existing & under construction)***

   (a) Laser Interferometer Gravitational-Wave Observatory (LIGO)

   (b) Virgo (European Gravitational Observatory

   (c) Kamioka Gravitational Wave Detector (KAGRA)

   (d) International Pulsar Timing Array (IPTA)

   (e) Laser Interferometer Space Antenna (LISA)

   (f) LIGO-India

5. *LIGO : Documentaries* - **a.** Inventing LIGO (1), **b.** Inventing LIGO (2)

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