Gravitational wave detection from stellar mass black hole binaries

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GW150914

• The Center for Gravitational Wave Astronomy is now a center for a real discipline.



- Laser Interferometer Gravitational-wave Observatory (LIGO) has observed gravitational waves from the inspiral and coalescence of at least two stellar-mass black hole binaries.
- Details of the generation of waves at the source and detection of the waves at the interferometer.
- Using the waveform to determine the properties of the source.
- Prospects for detection with Laser Interferometer Space Antenna (LISA)

Outline

- Gravitational radiation emission from the source.
- Gravitational radiation detection from interferometers.
- Parameter estimation.
- Prospects for eLISA.

Emission from the source

To the detector





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http://www.soundsofspacetime.org/spinning-binaries.html

Can measure initial spins through spin-orbit coupling if enough cycles of inspiral are measured.

Interferometric Detection









Properties of the binary black hole merger GW150914











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Histogram of Inclinations



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Frequency (Hz)

Prospects for eLISA



If a binary black hole merges, this implies that there are many more binary black holes at lower frequencies.

These will be eLISA sources



MB, Hinojosa, Mata, Belczynski 2015

• Frequency evolution of a binary: $\dot{f} = k_0 f^{11/3}$

$$k_0 = \frac{96}{5} \left(2\pi\right)^{8/3} \frac{G^{5/3}}{c^5} \frac{m_1 m_2}{M^{1/3}}$$

• Number density of binaries in frequency range df:

$$dn = \frac{\eta}{k_0} f^{-11/3} df$$

• Number density of binaries above *f*_{min}:

$$n = \frac{\eta}{k_0} \frac{3}{8} f_{\min}^{-8/3}$$

Volume to 30 Mpc and minimum frequency of 1 mHz.

Merger rate in events/Gpc³/yr.

All systems with same chirp mass.

The number of systems in this volume is numerically equal to the merger rate.

Expect more than 2-400 systems within 30 Mpc in the eLISA band.



Sesana 2016

eLISA error box superimposed on a chart of the Virgo cluster, centered on NGC 4365 for a typical BBH signal.





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