Gravitational Wave Physics
Strain, Detection, and Binary Systems

Gravitational Wave Astronomy Group

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Abstract

Analysis of gravitational wave generation, propagation, and detection including chirp mass calculations and LIGO sensitivity.

1 Introduction

Gravitational waves are ripples in spacetime caused by accelerating masses.

2 Chirp Mass

$\mathcal{M} = \frac{(m_1 m_2)^{3/5}}{(m_1+m_2)^{1/5}}$

Figure 1: Chirp mass for different binary configurations.

3 Gravitational Wave Frequency

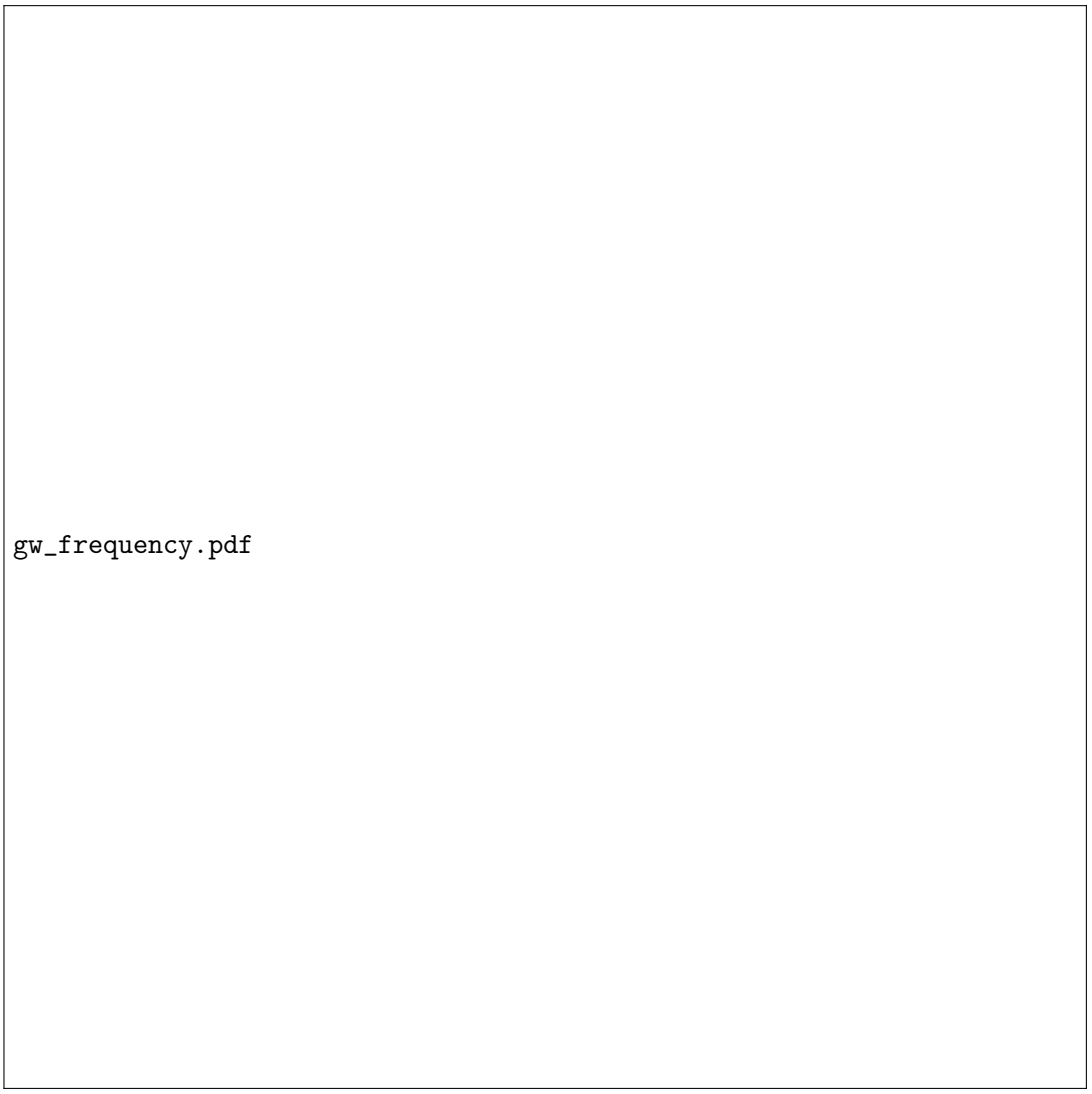

Figure 2: GW frequency dependence on binary separation.

4 Strain Amplitude

$h = \frac{4}{D}\left(\frac{G\mathcal{M}}{c^2}\right)^{5/3}\left(\frac{\pi f}{c}\right)^{2/3}$

Figure 3: Gravitational wave strain amplitude.

5 Inspiral Waveform

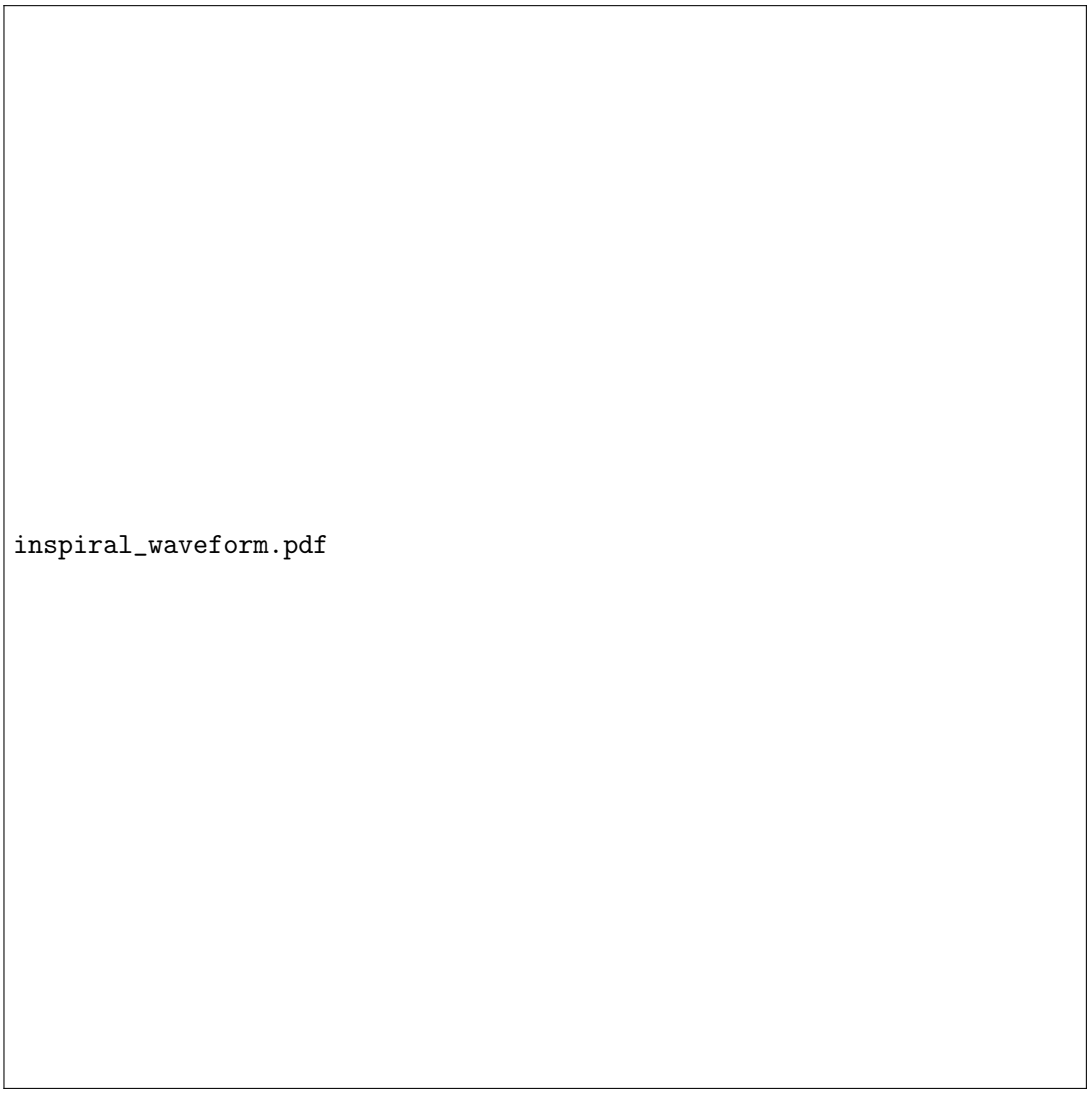

Figure 4: Binary inspiral frequency and waveform evolution.

6 LIGO Sensitivity

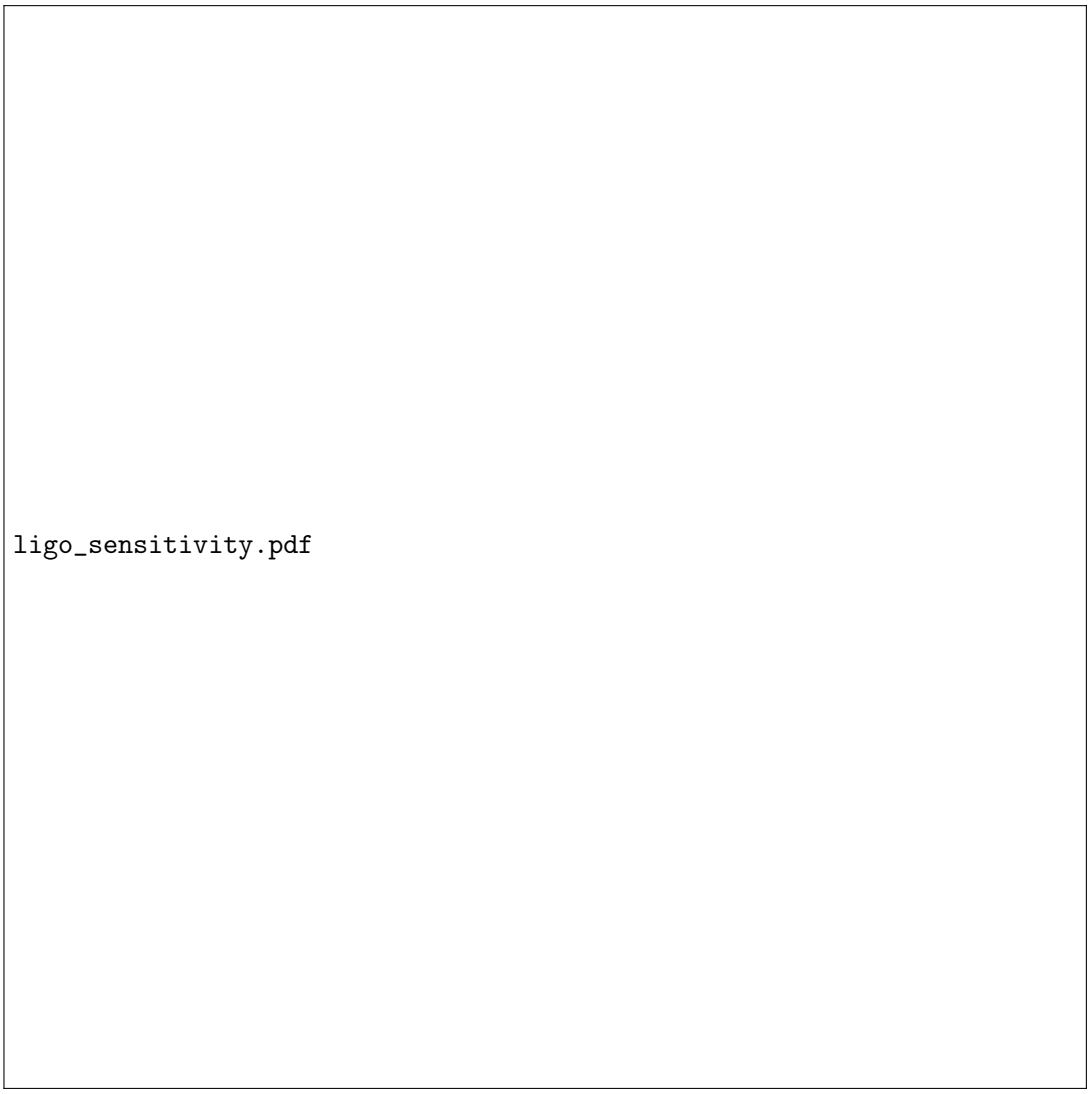

Figure 5: LIGO detector sensitivity curve.

7 Energy Radiated

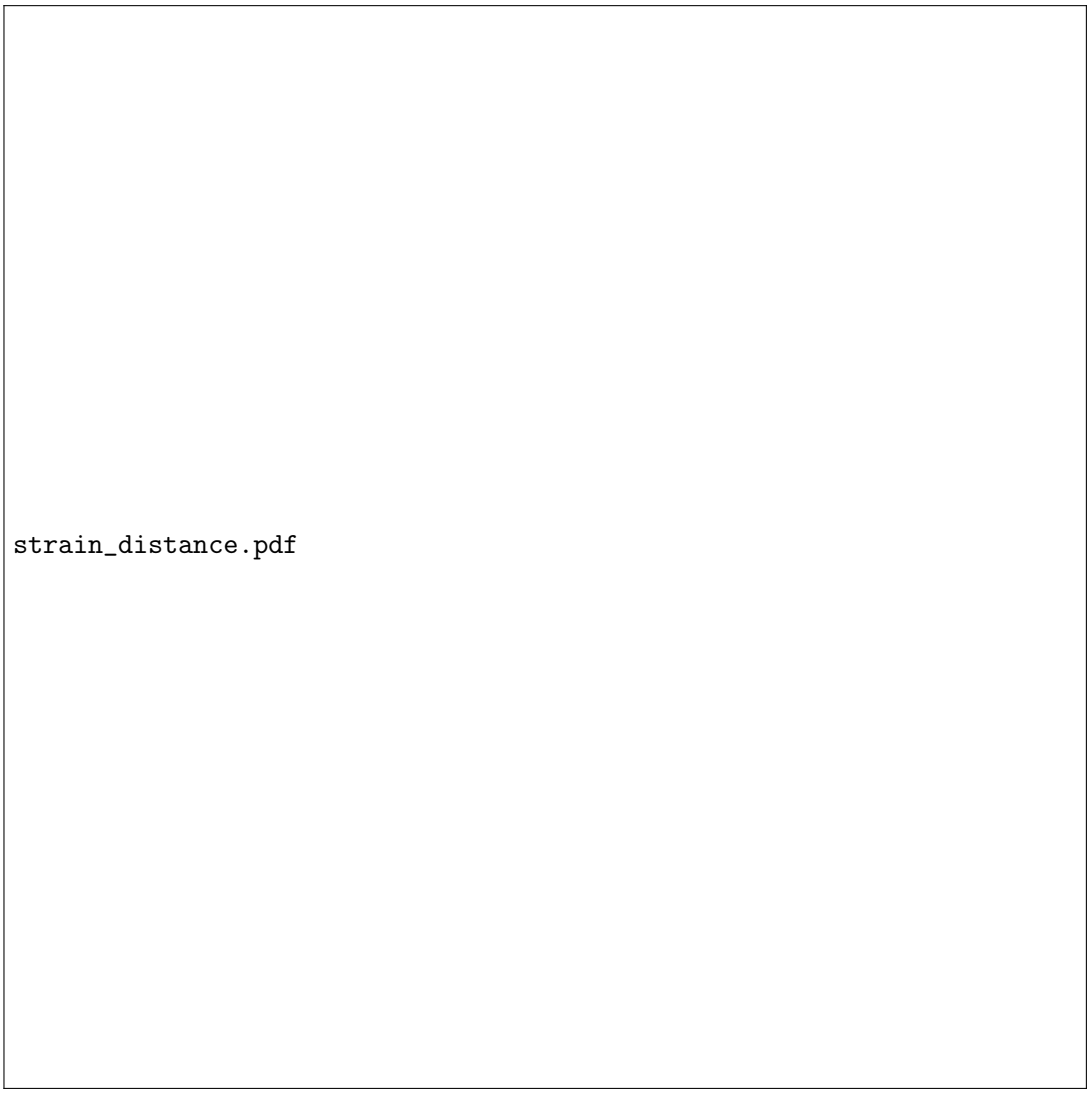

Figure 6: GW strain as function of source distance.

8 Merger Rate

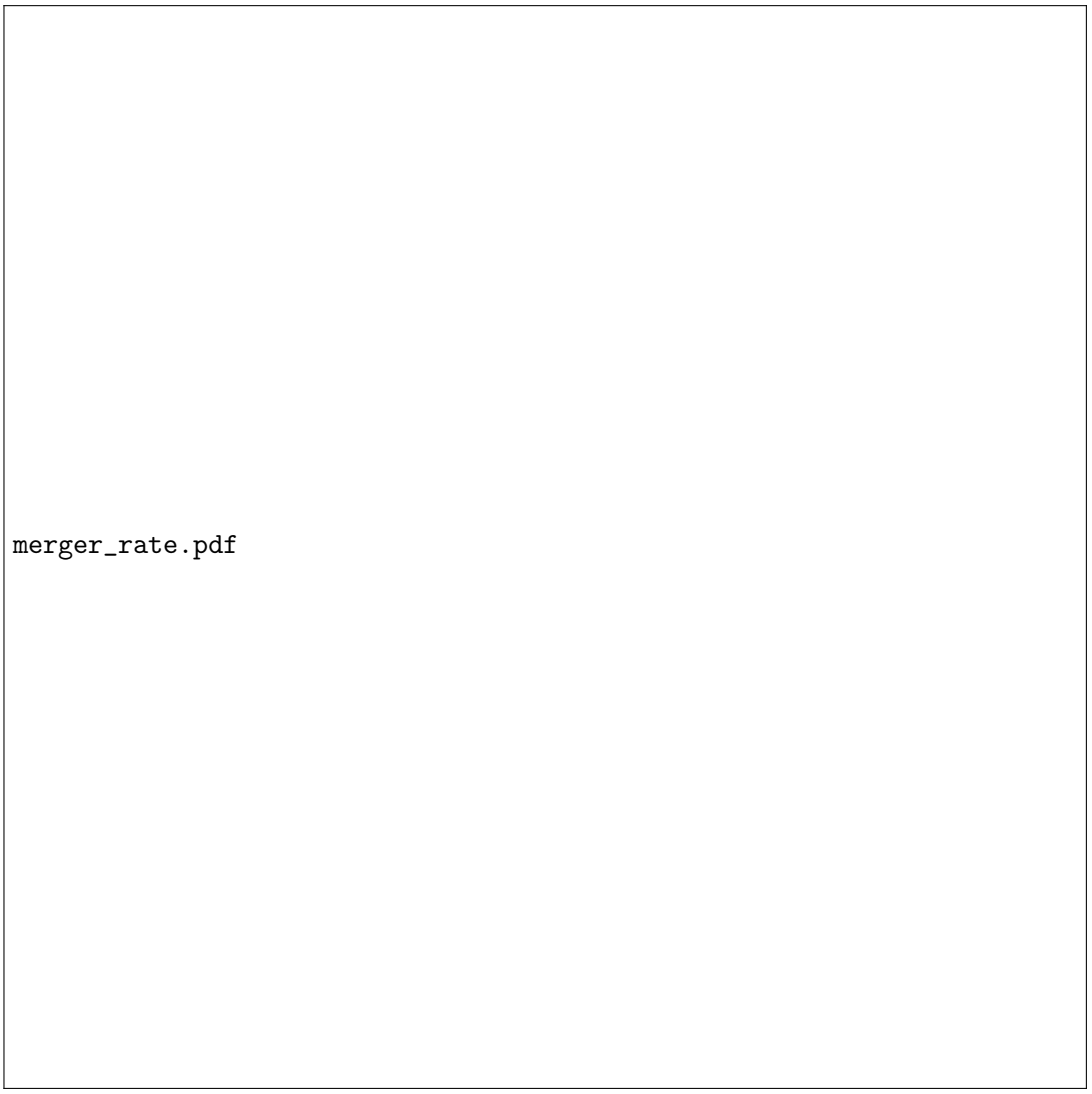

Figure 7: Merger rate evolution with redshift.

9 Results

10 Conclusions

Gravitational wave astronomy provides unique insights into compact binary systems and strong-field gravity.