Stochastic GW background from compact binary mergers

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Collaborations : LISA, Einstein Telescope

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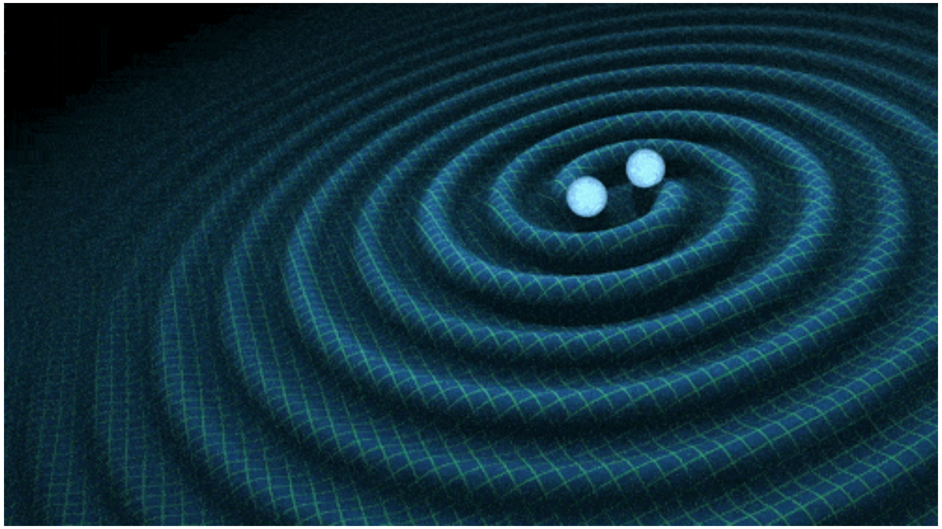
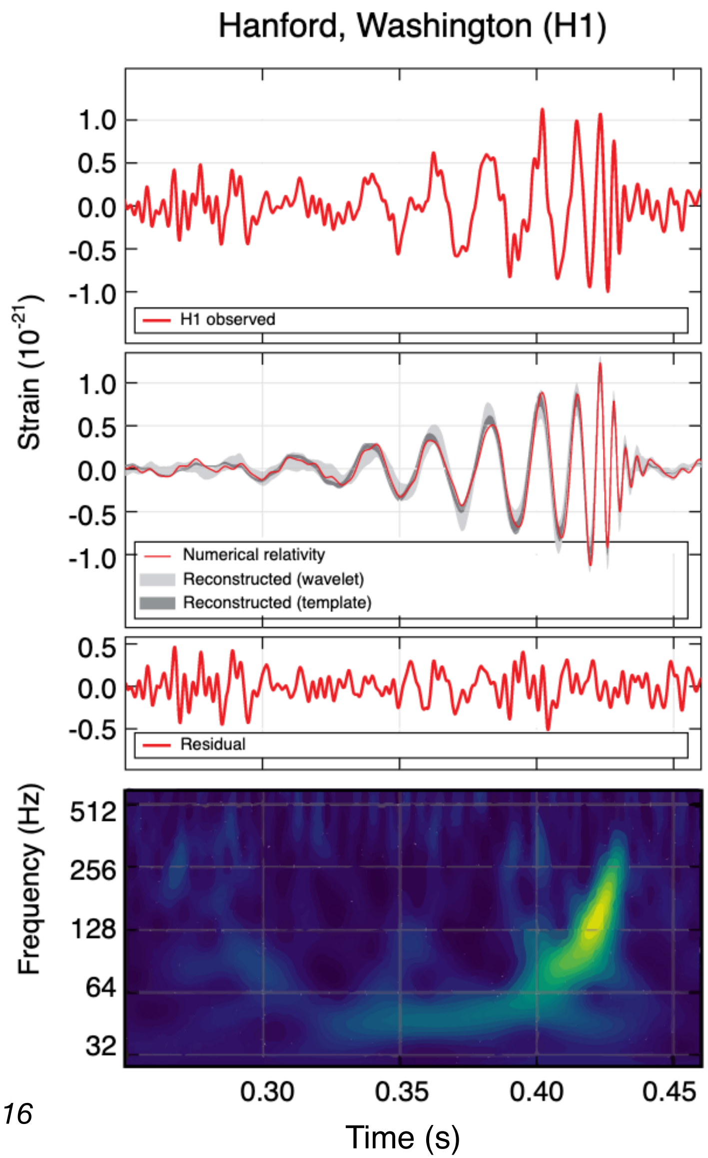
Gravitational waves

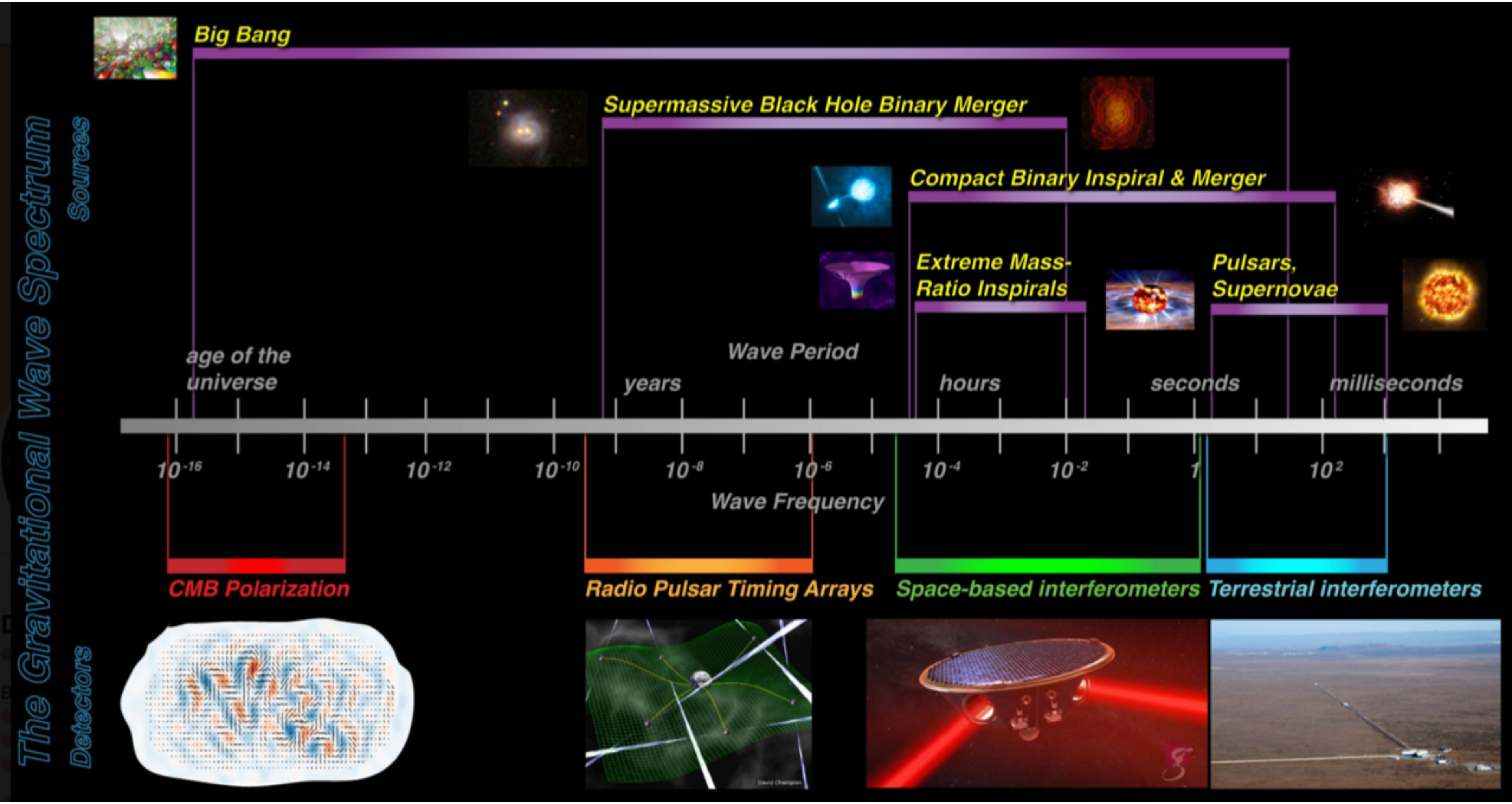
- ~ **90 BBHs** mergers detected
- ~ **2 BH-NS** mergers detected
- ~ **2 BNS** mergers detected





Observation of Gravitational Waves from a Binary Black Hole Merger,
B.P. Abbott et al. , Phys. Rev. Lett. 116, 061102 – Published 11 February 2016

Gravitational wave spectrum



Kelly Holley-Bockelmann and Joey Shapiro Key et al. Building a field: The future of astronomy with gravitational waves, a state of the profession consideration for astro2020. *arXiv: Instrumentation and Methods for Astrophysics*, 2019.

Stochastic GW Background

There are two types of stochastic backgrounds:

- The **astrophysical background** (unresolved superposition)
- The **cosmological background** (produced in the primordial universe)

$$\Omega_{\mathrm{GW}} = \frac{1}{\rho_c} \frac{\mathrm{d}\rho_{\mathrm{GW}}}{\mathrm{d}\log f}$$

We are interested in the stochastic **astrophysical** background produced by **compact binaries** for **LIGO/Virgo** and **LISA**.

Merger rate of compact binaries

$$R_{\mathrm{merg}}(t) = \int_0^{Z_{\mathrm{max}}} \int_{t_{d,\mathrm{min}}}^{t_{d,\mathrm{max}}} \alpha(Z)\, \psi(t - t_d)\, P(t_d|Z)\, P(Z|t - t_d)\, dt_d\, dZ$$

Merger rate of compact binaries

Mass efficiency

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Star formation rate

Merger rate of compact binaries

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Star formation rate

Time delay distribution

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Baseline model

Baseline_delays model

Metallicity cut model

$$P(t_d) \propto t_d^{-1}$$

$$Z_{\mathrm{cut}} = 0.1\, Z_{\odot}$$

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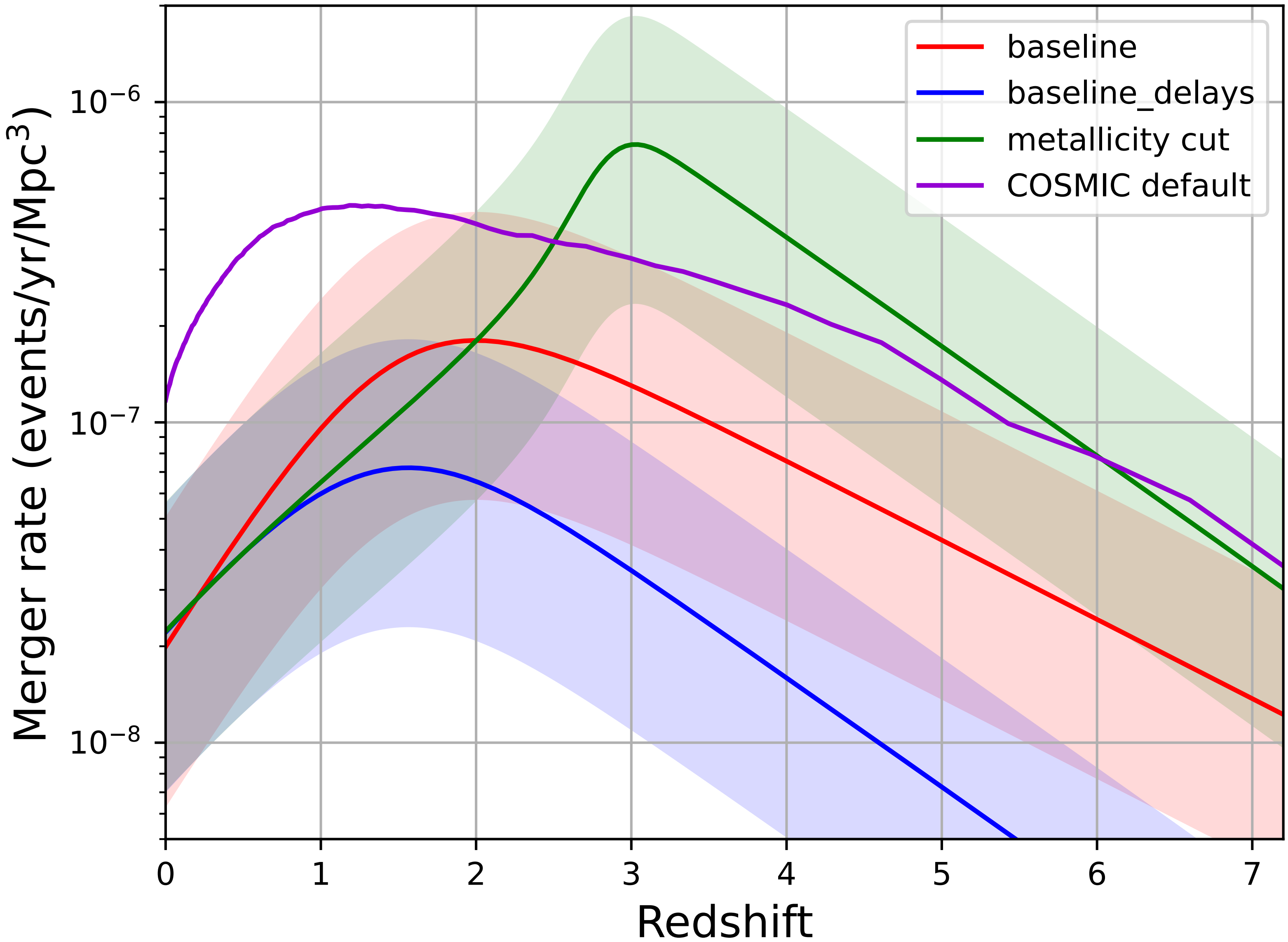
Pop. Synth. models

Exploration of stellar evolution

Srinivasan et al. 2303.04017

Pellouin et al. in prep

Merger rate of BBHs



Stochastic GW Background

$$\Omega_{\mathrm{GW}}(f) = \frac{f}{\rho_c c^2 H_0} \int_0^{z_{\max}} \int_\lambda \frac{R_{\mathrm{merg}}(z,\lambda)\, \frac{dE_{GW}(f_s)}{df_s}\, P(\lambda)}{(1+z)\sqrt{\Omega_M (1+z)^3 + \Omega_\Lambda}}\, d\lambda\, dz$$

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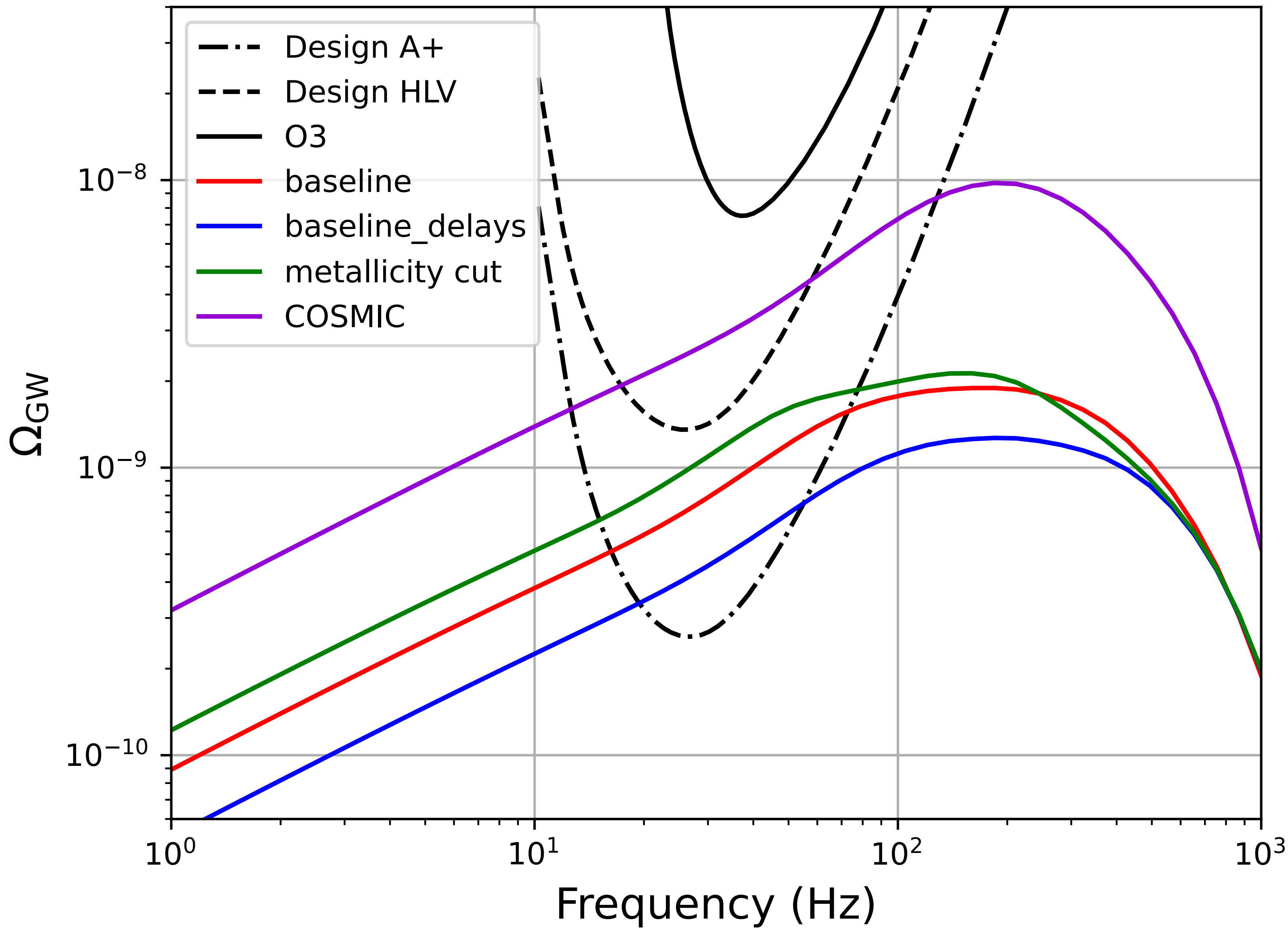
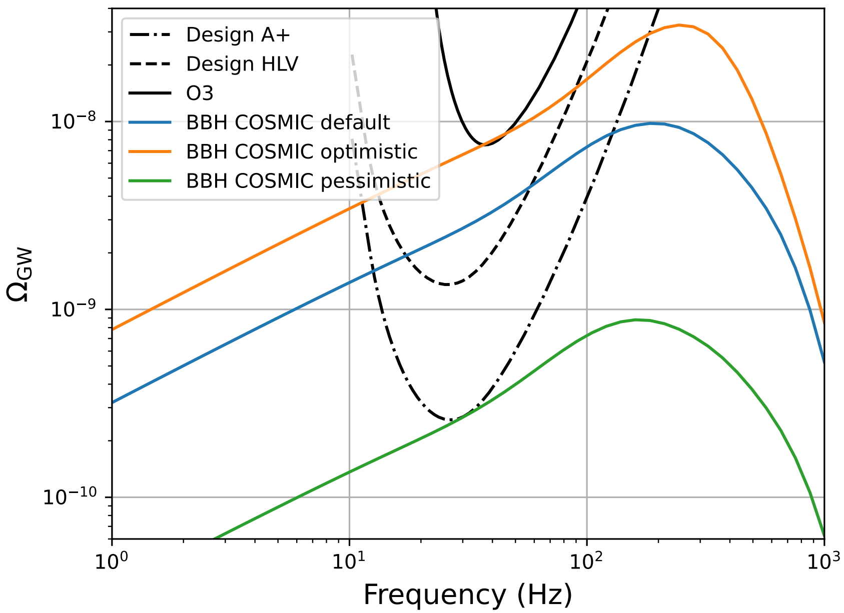
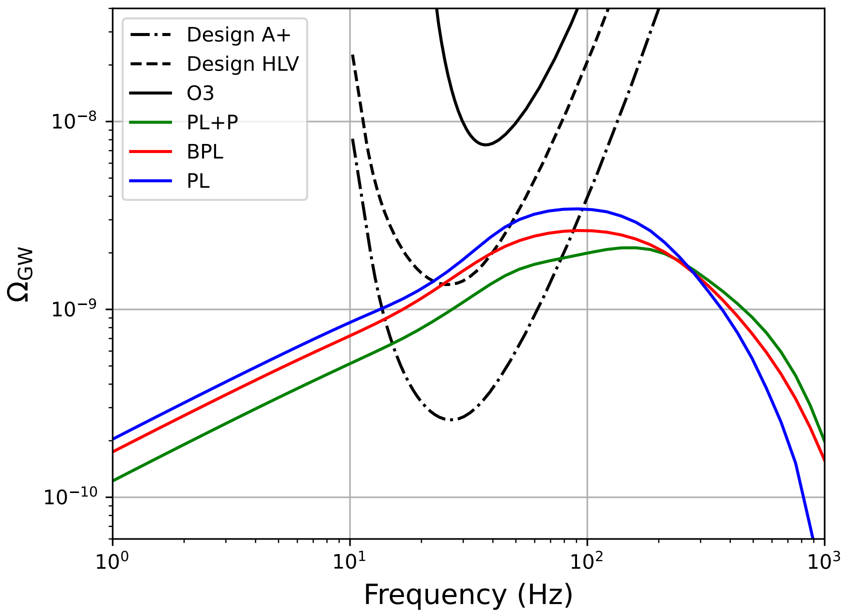
We explored the effects of the astrophysical uncertainties on the SGWB.

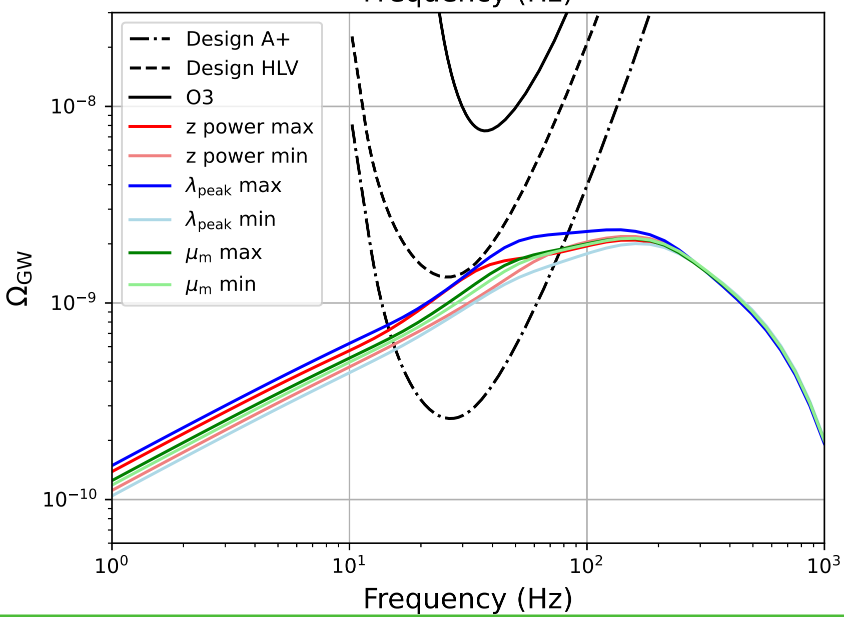
SGWB from BBHs

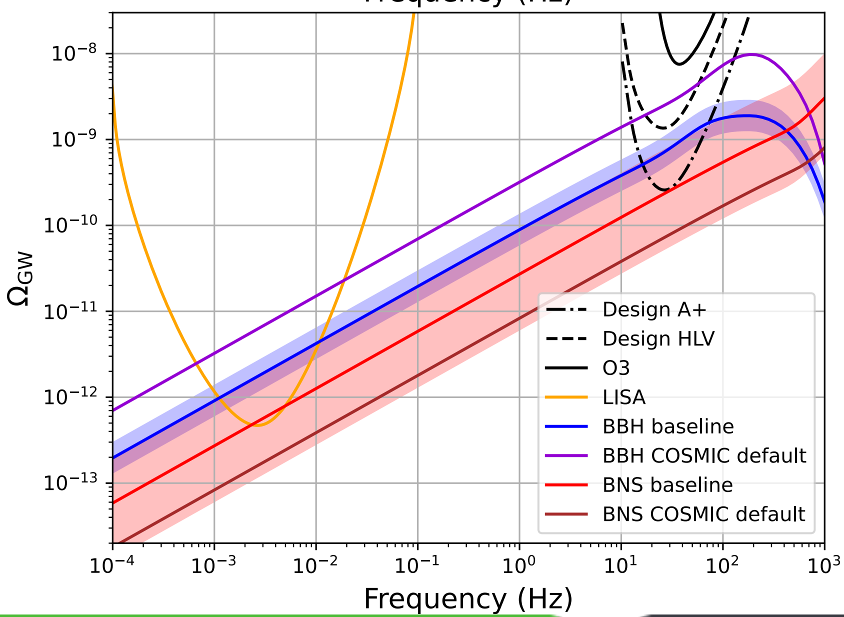


SGWB uncertainties









Conclusion

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- We find that some our models could be even more constrained with upcoming observations.

- A few BBHs mergers might be detectable by LISA.