Stochastic GW background from merging binaries

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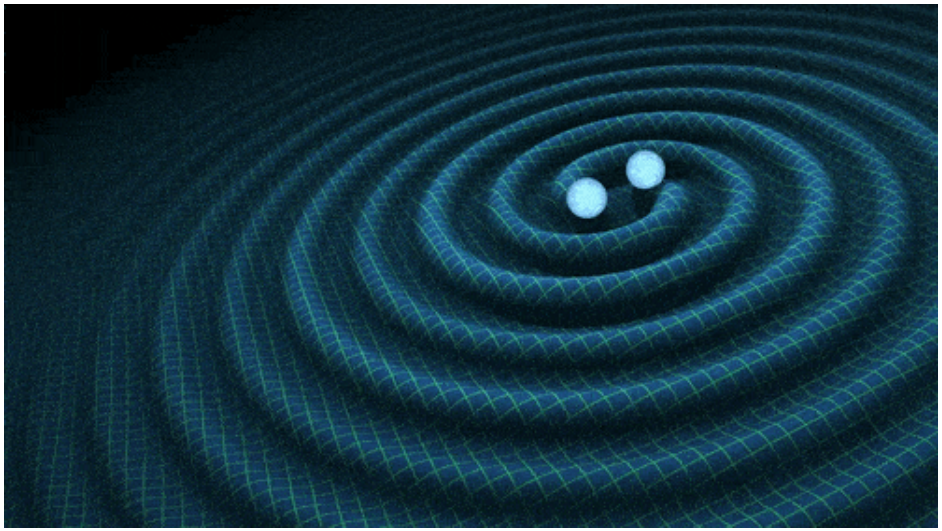
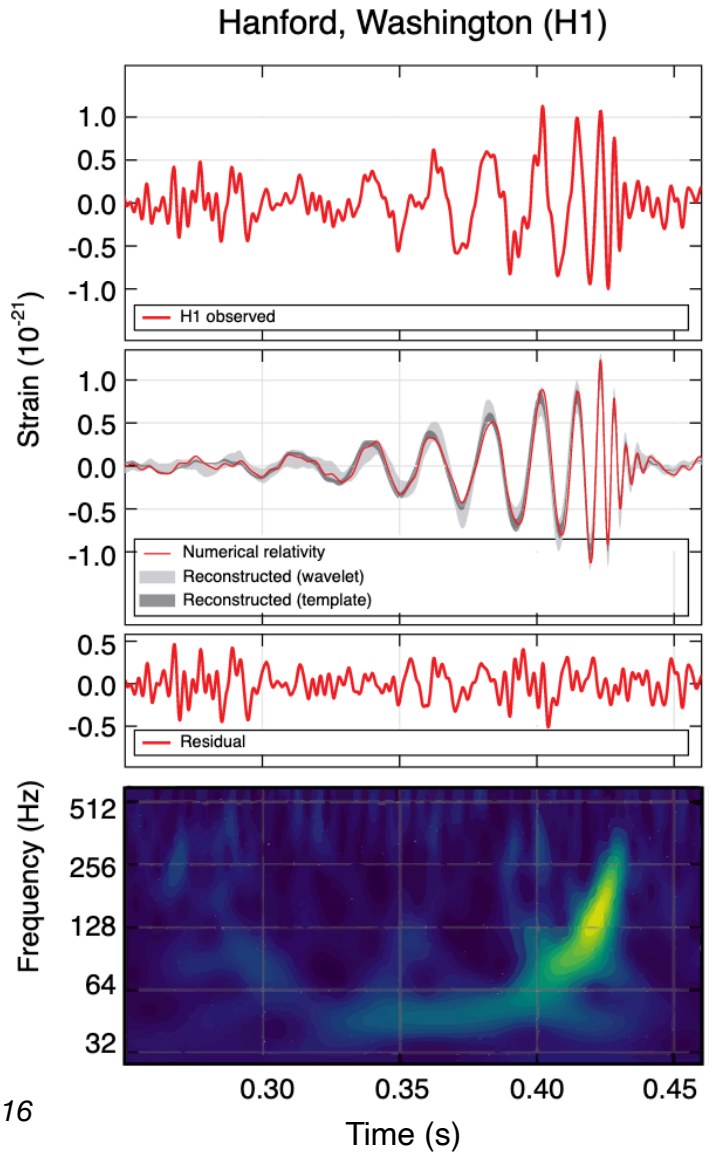
Gravitational wave events

- ~ 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

Stochastic GW Background

There are two types of stochastic backgrounds:

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

$$\Omega_{\rm GW} = \frac{f}{\rho_c}\frac{d\rho_{\rm GW}}{df}$$

We are interested in the stochastic astrophysical background produced by compact binaries.

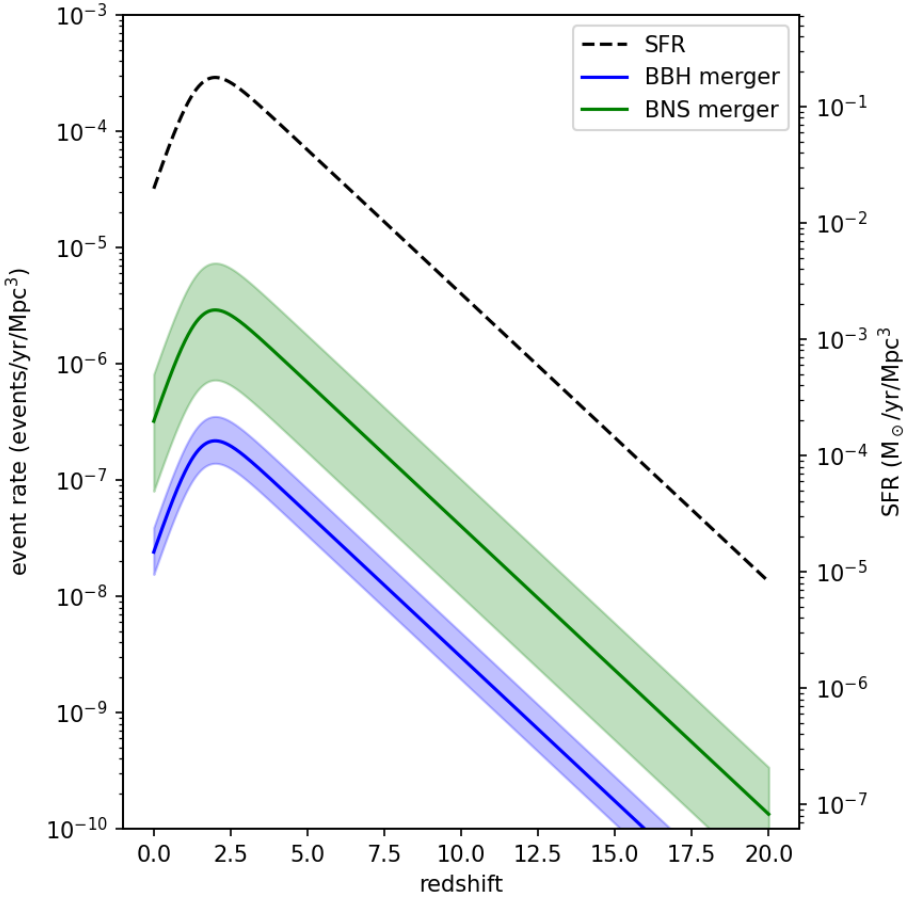
Stochastic GW Background

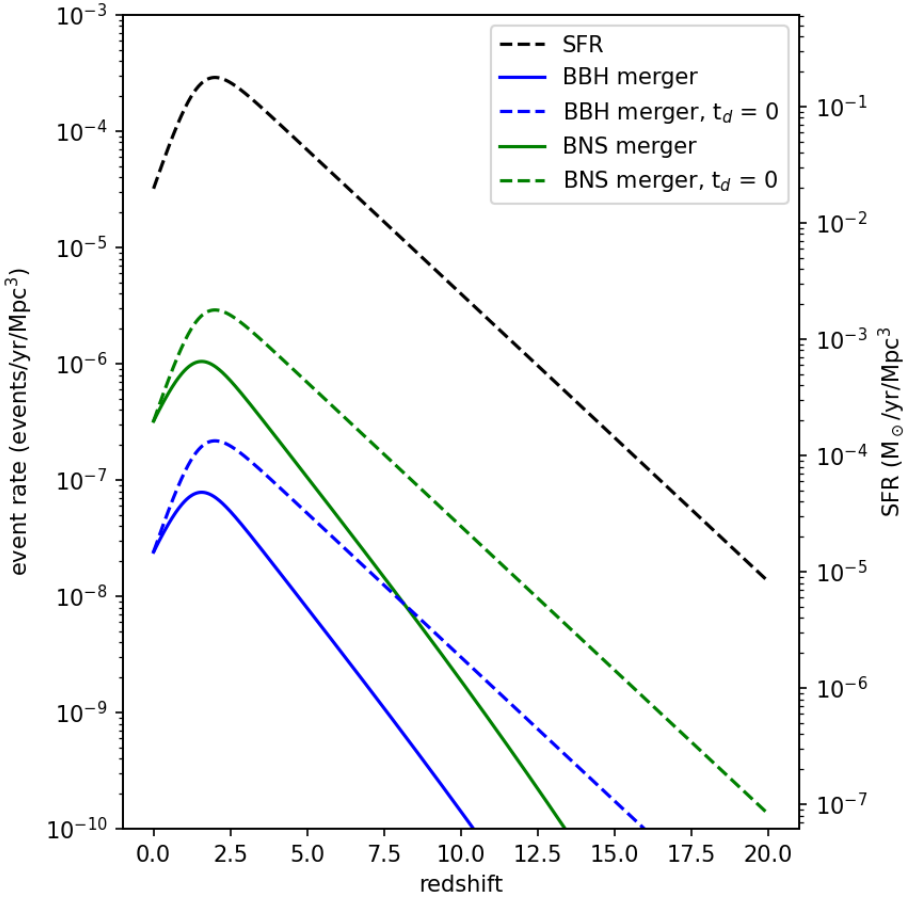
$$\Omega_{\rm GW} = \frac{f}{\rho_c c^2 H_0} \int_0^{z_{\rm max}} \int_{M_{1,\rm min}}^{M_{1,\rm max}} \frac{R_{\rm merg}(z) \frac{dE_{GW}(f_s)}{df_s} P(M_1)}{(1+z)\sqrt{\Omega_M (1+z)^3 + \Omega_\Lambda}} dM_1\, dz$$

- What is this background for BNS and BBHs ?
- To what extent is it detectable by LIGO/Virgo and LISA ?
- Phenomenological and population synthesis models.

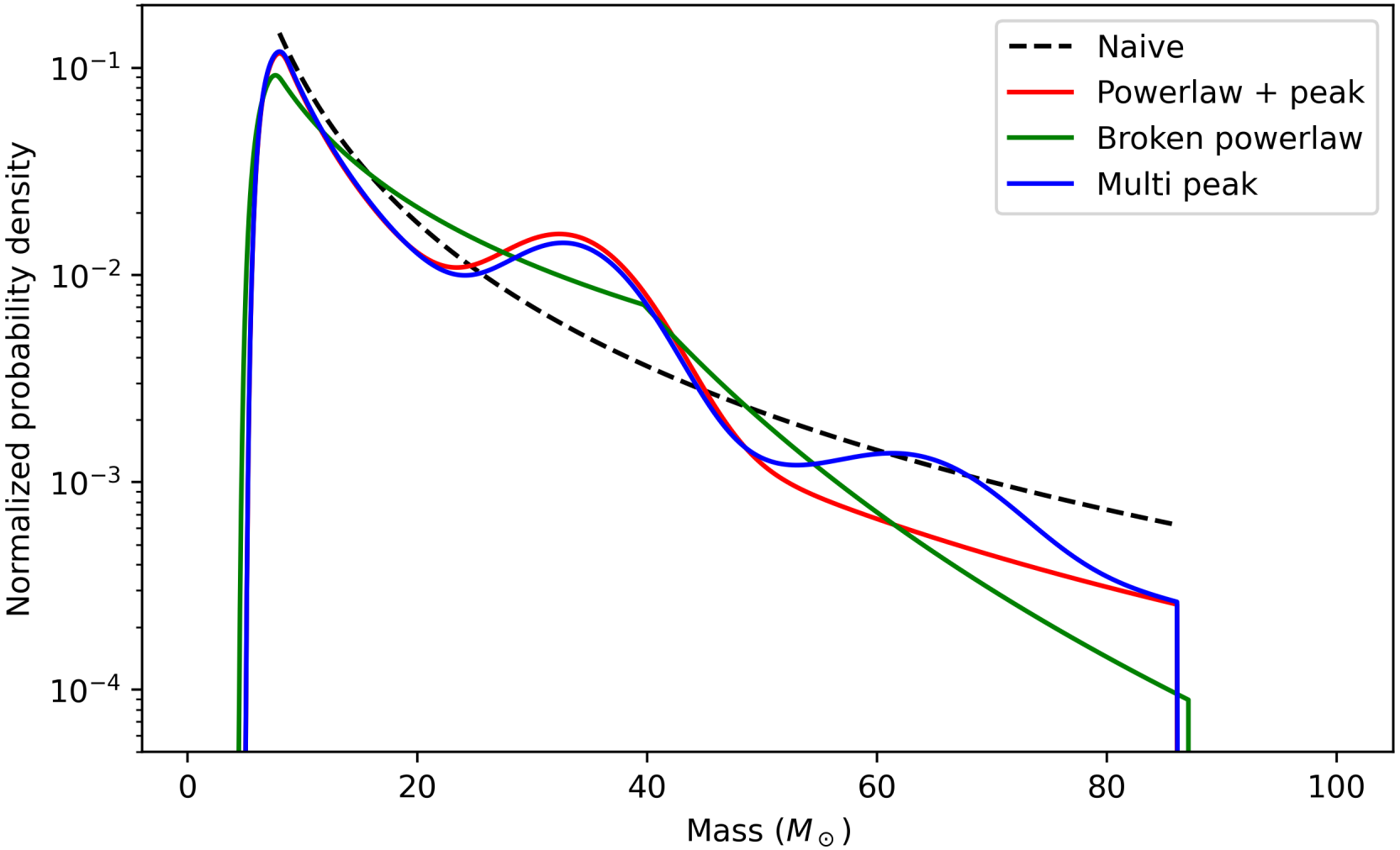
Merger rate of compact binaries

$$R_{\rm merg}(t) = \alpha \int_{t_{d,\rm min}}^{t_{d,\rm max}} \phi(t - t_d)\, P(t_d)\, dt_d$$

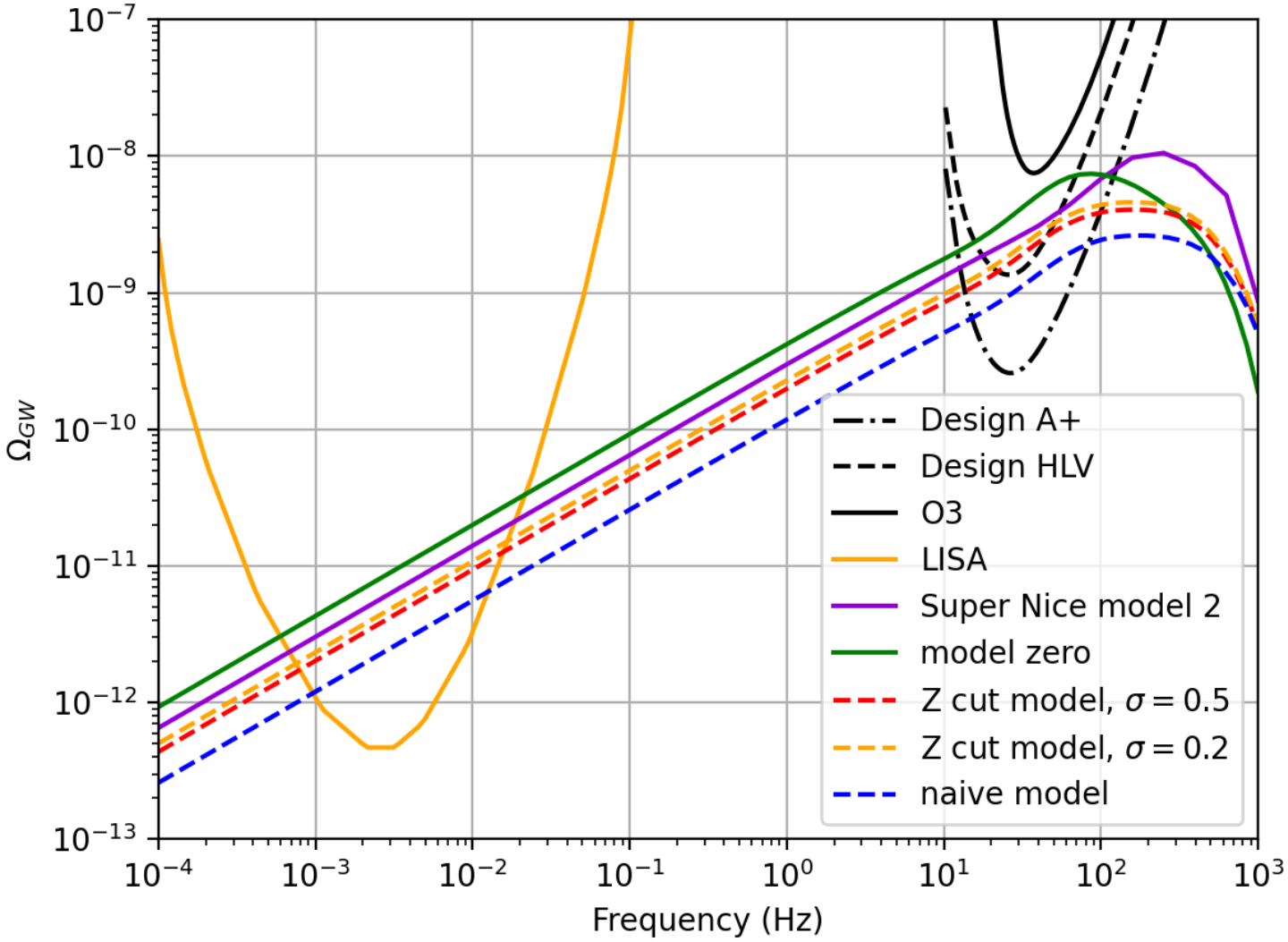




Mass distribution of BBHs - LVK catalogue

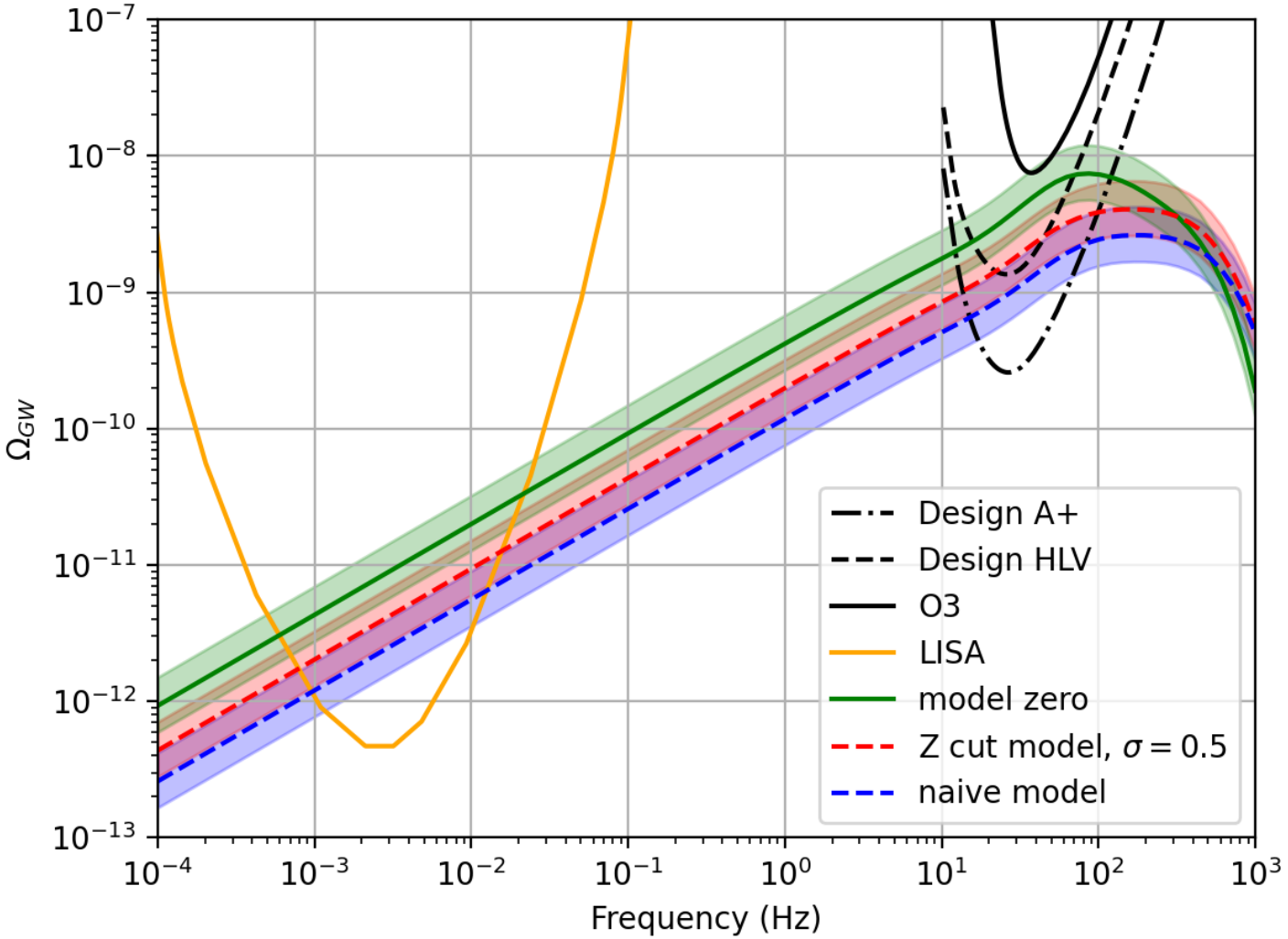


Comparison of the different models



Collaboration with A. Lamberts, R. Srinivasan, T. Bruel (Nice)

Observation uncertainties



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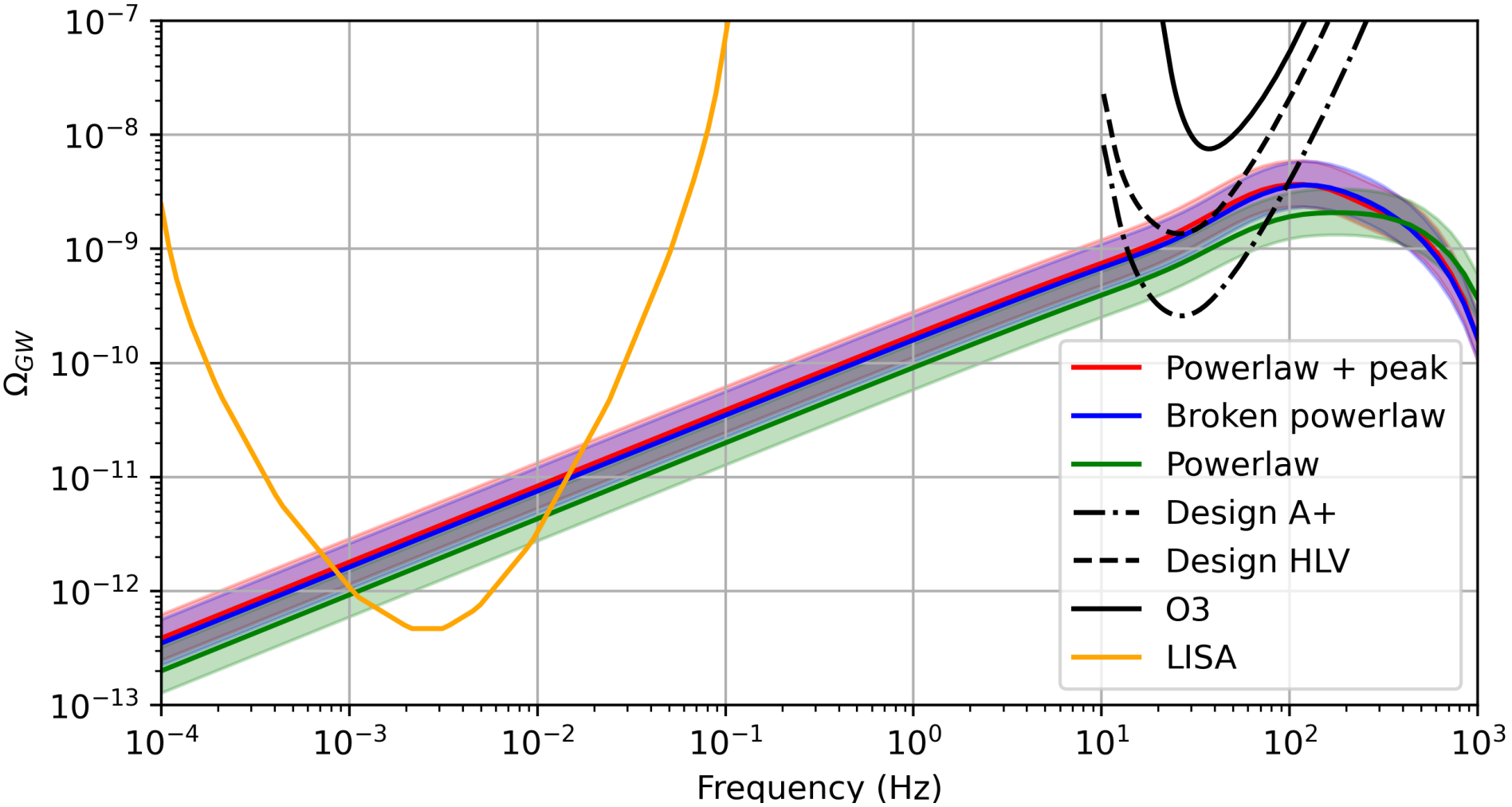
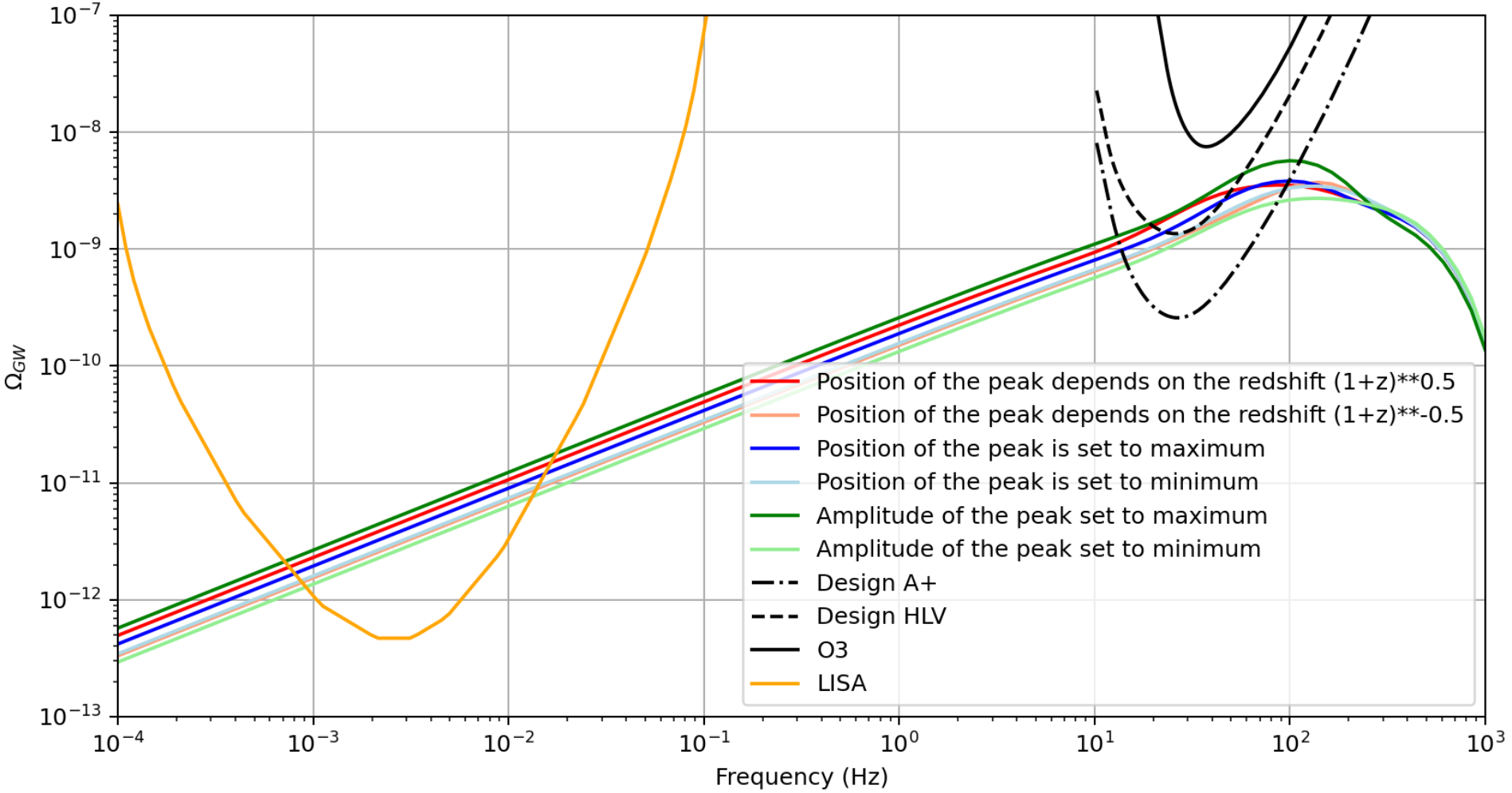
Influence of the mass distribution model



Variability of the PL+P mass distribution



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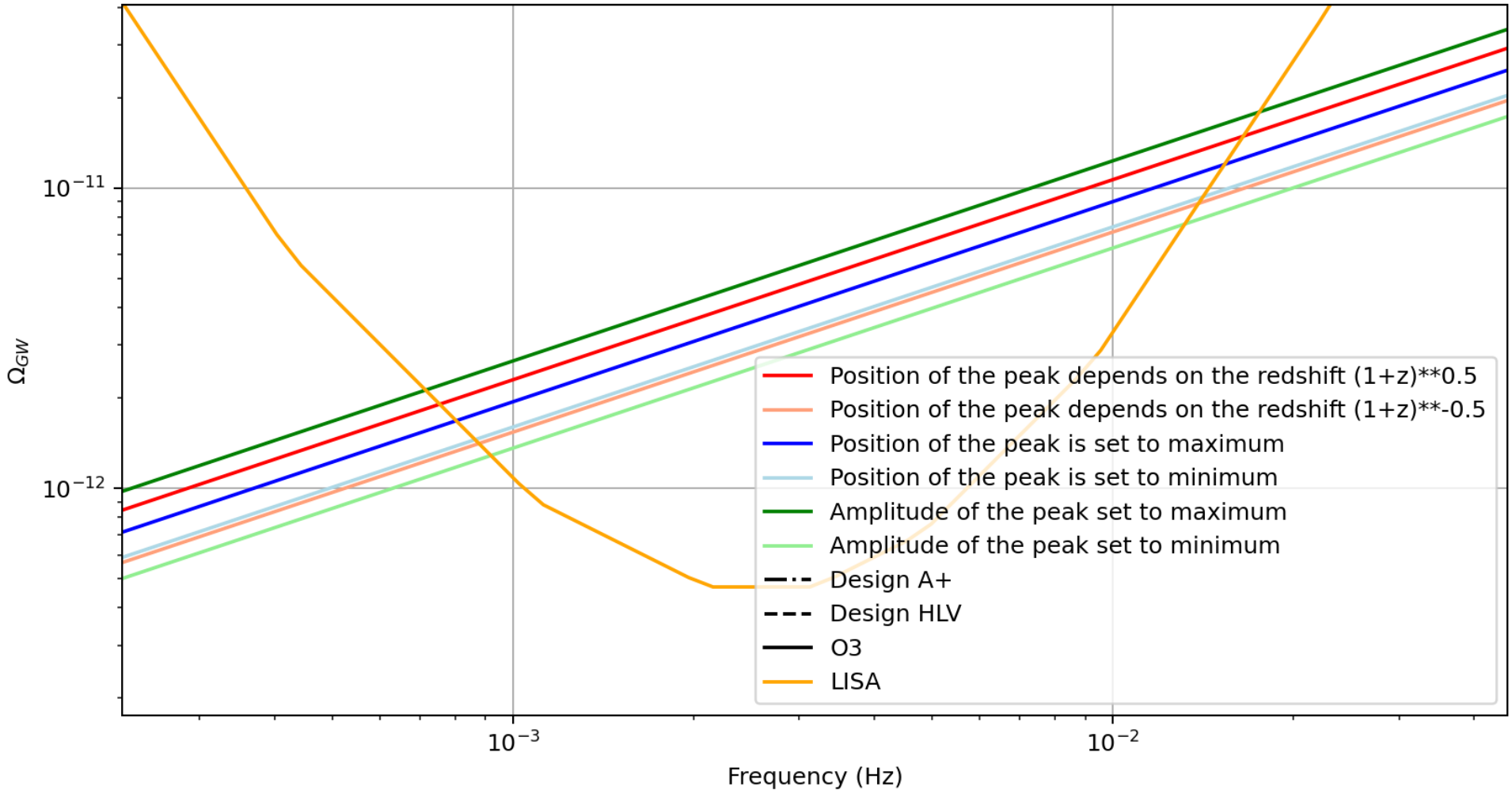
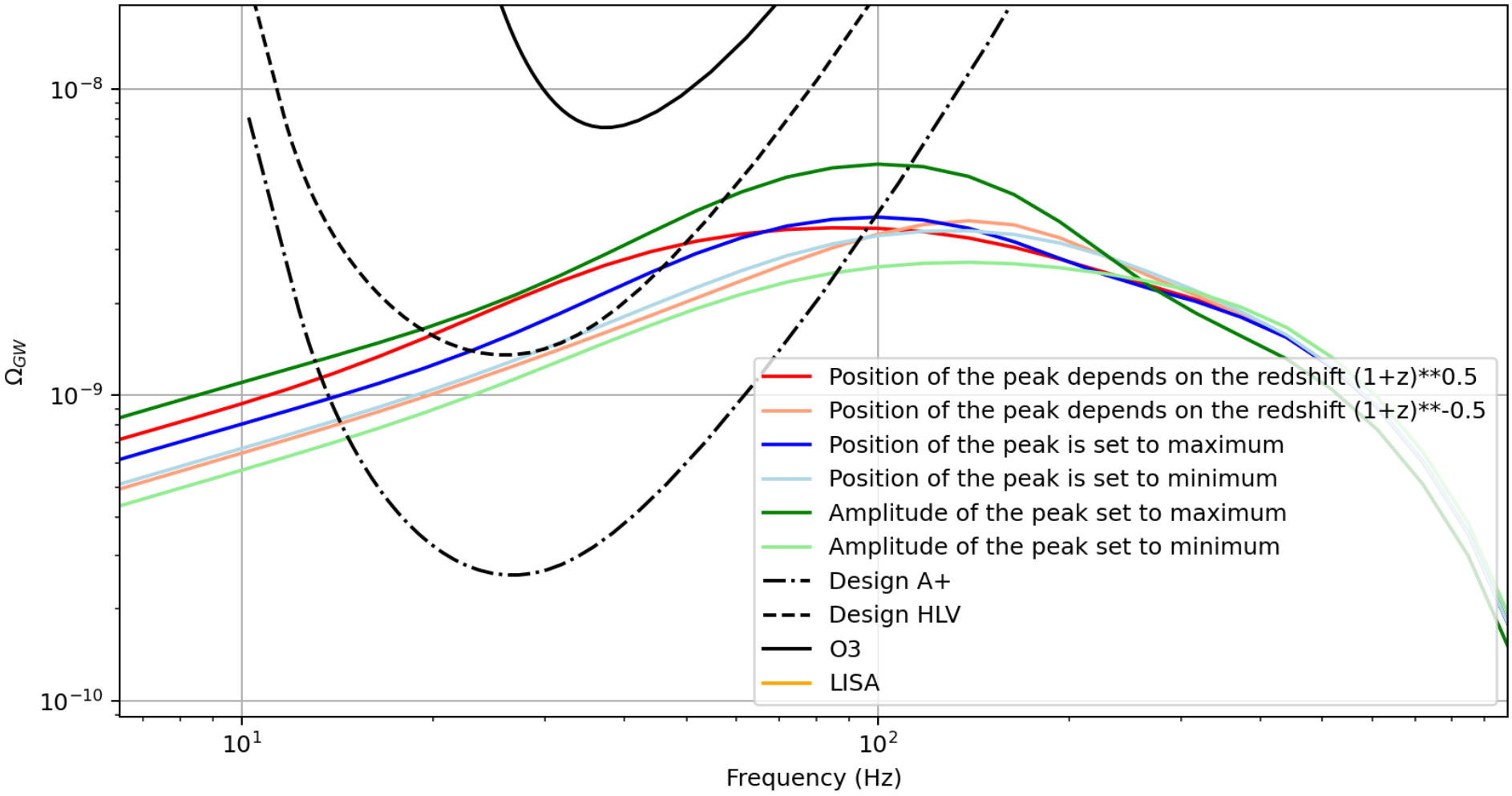
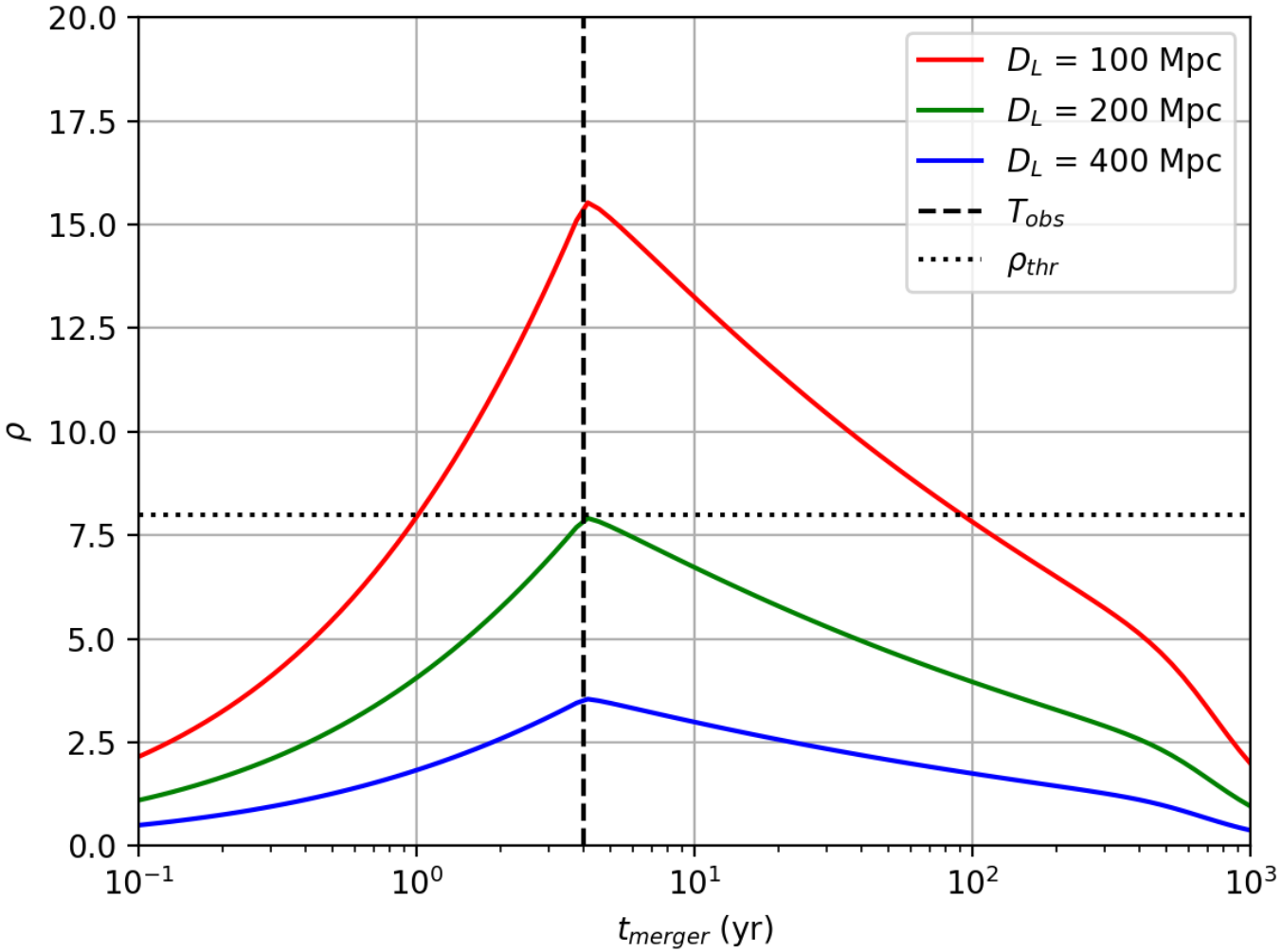


Variability of the PL+P mass distribution



Individually detectable sources by LISA

$$N_{\rm space} = \int_z \int_{M_1} P(M_1)\, R_{\rm merg}(z)\, \frac{dV_c}{dz}\, \frac{1}{1+z}\, |t_{\rm thr1}(M_1, z) - t_{\rm thr2}(M_1, z)|\, dz\, dM_1$$



$N_{\rm space} \approx 10$

Merger rate of compact binaries

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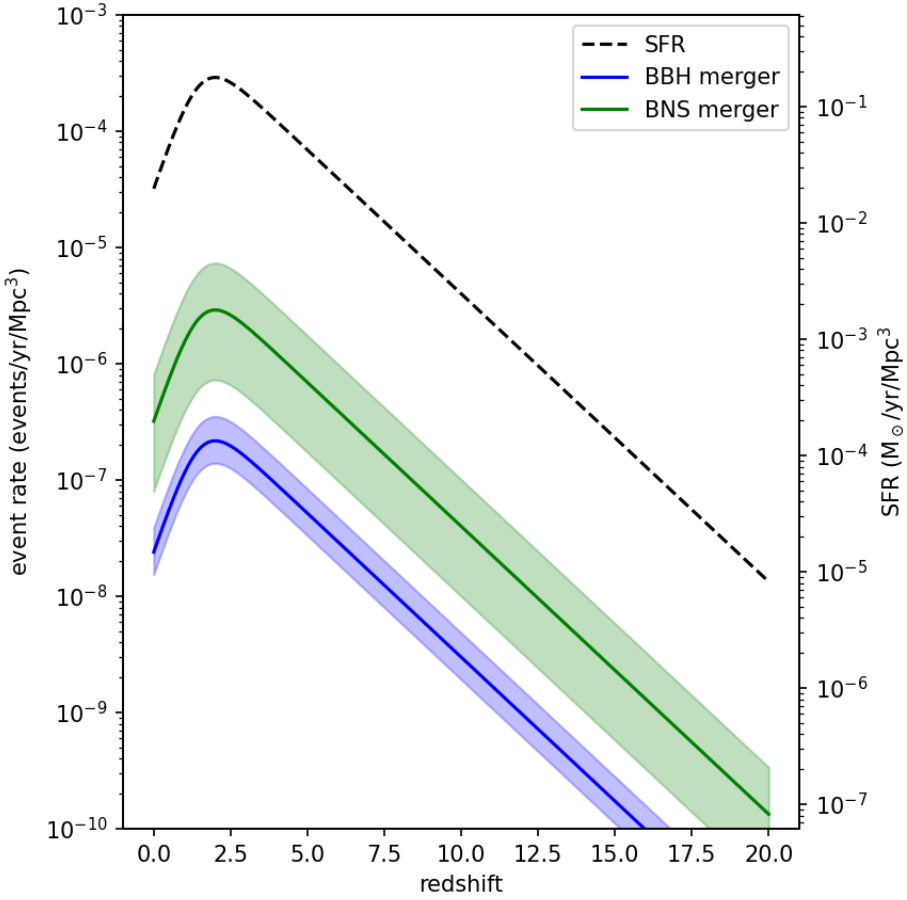
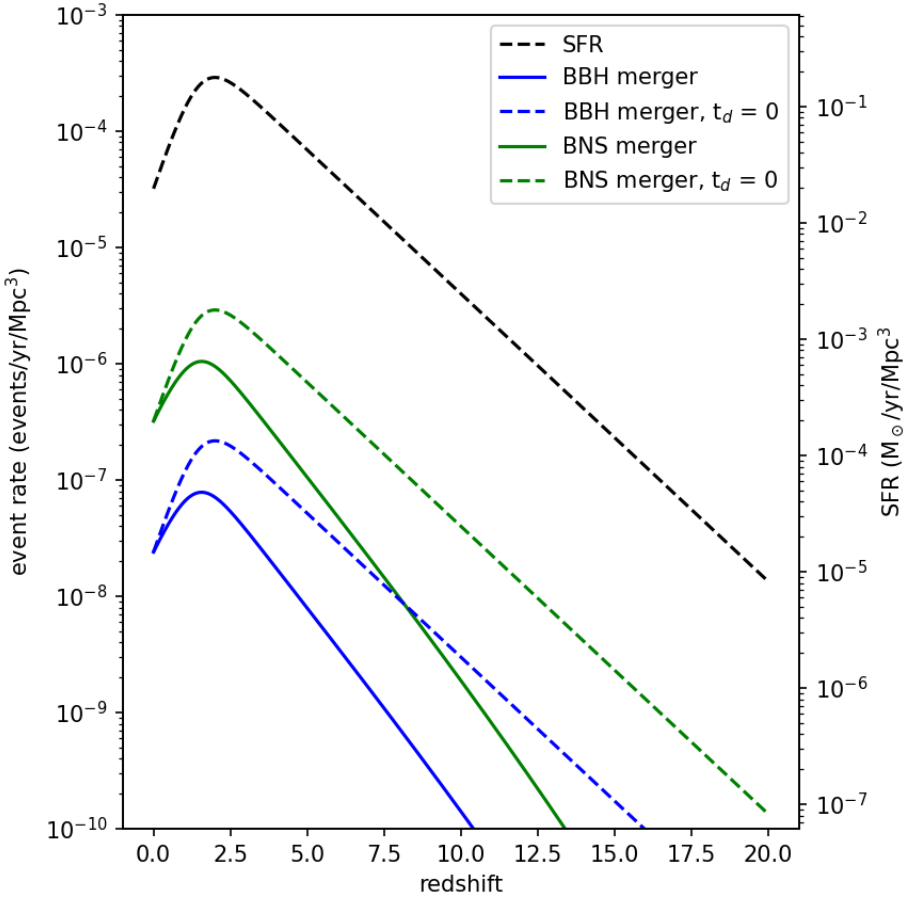
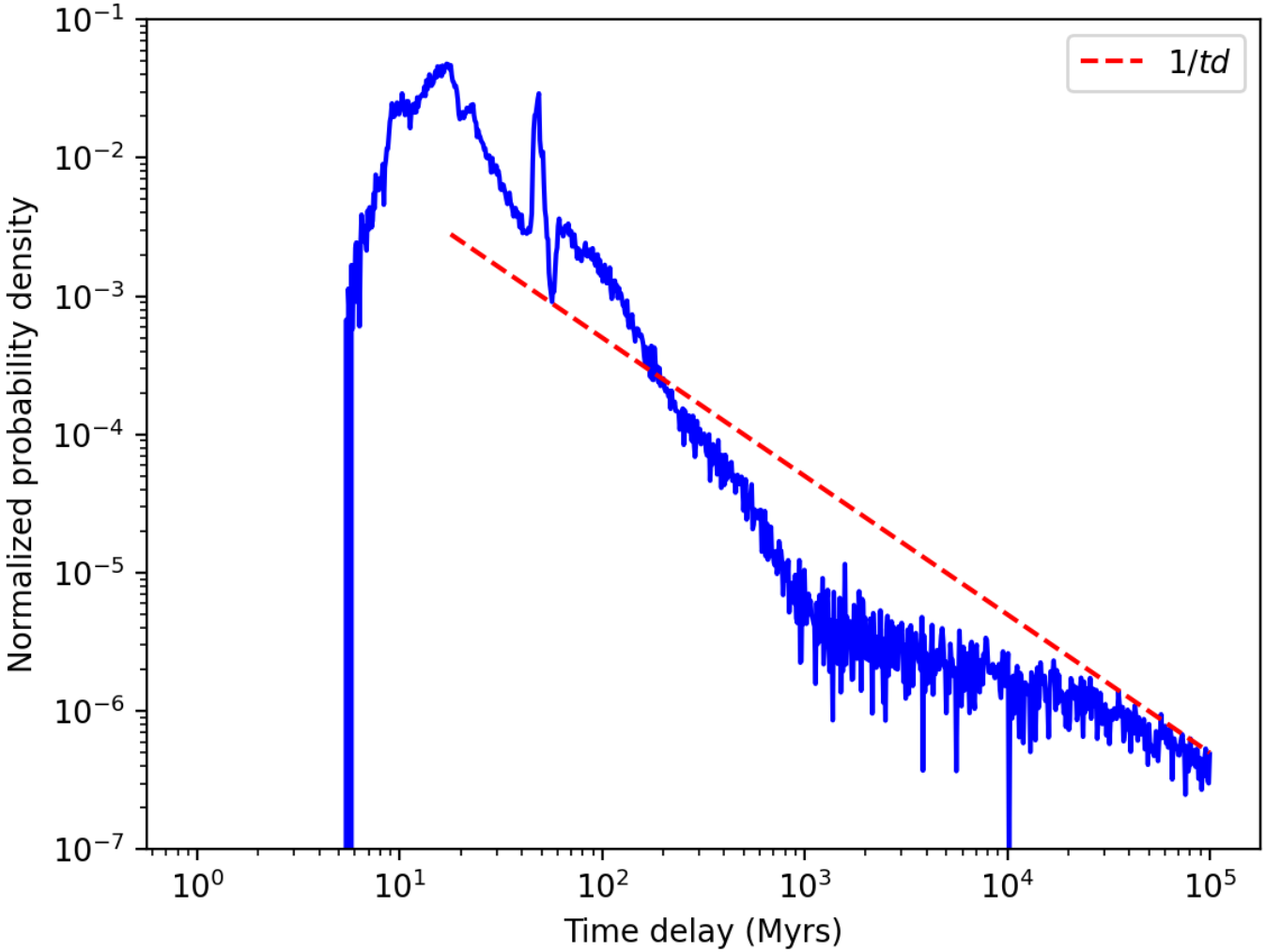


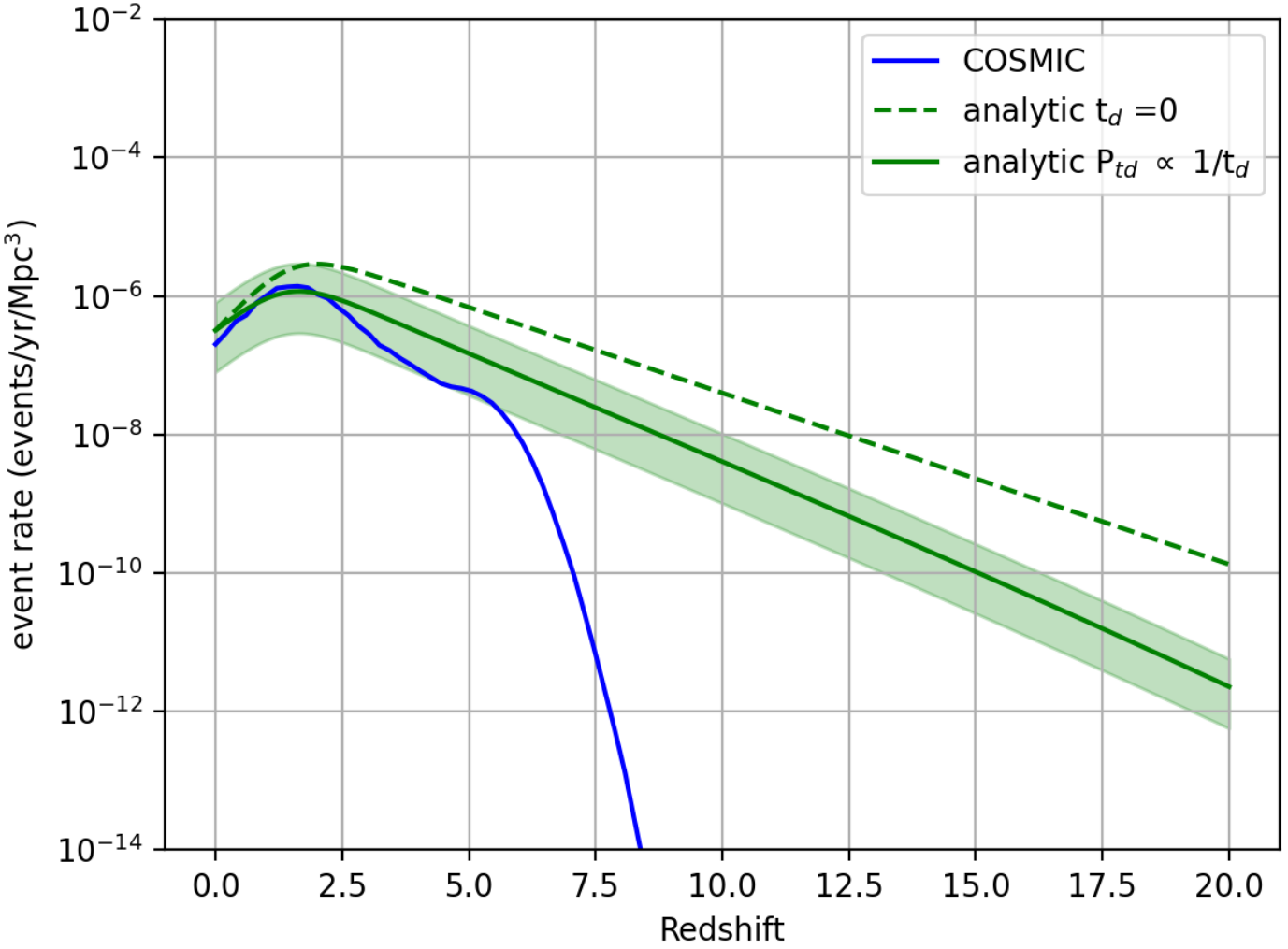


Time delay probability density - BNS



Pellouin, Dvorkin, Lehoucq in prep

Merger rate - BNS



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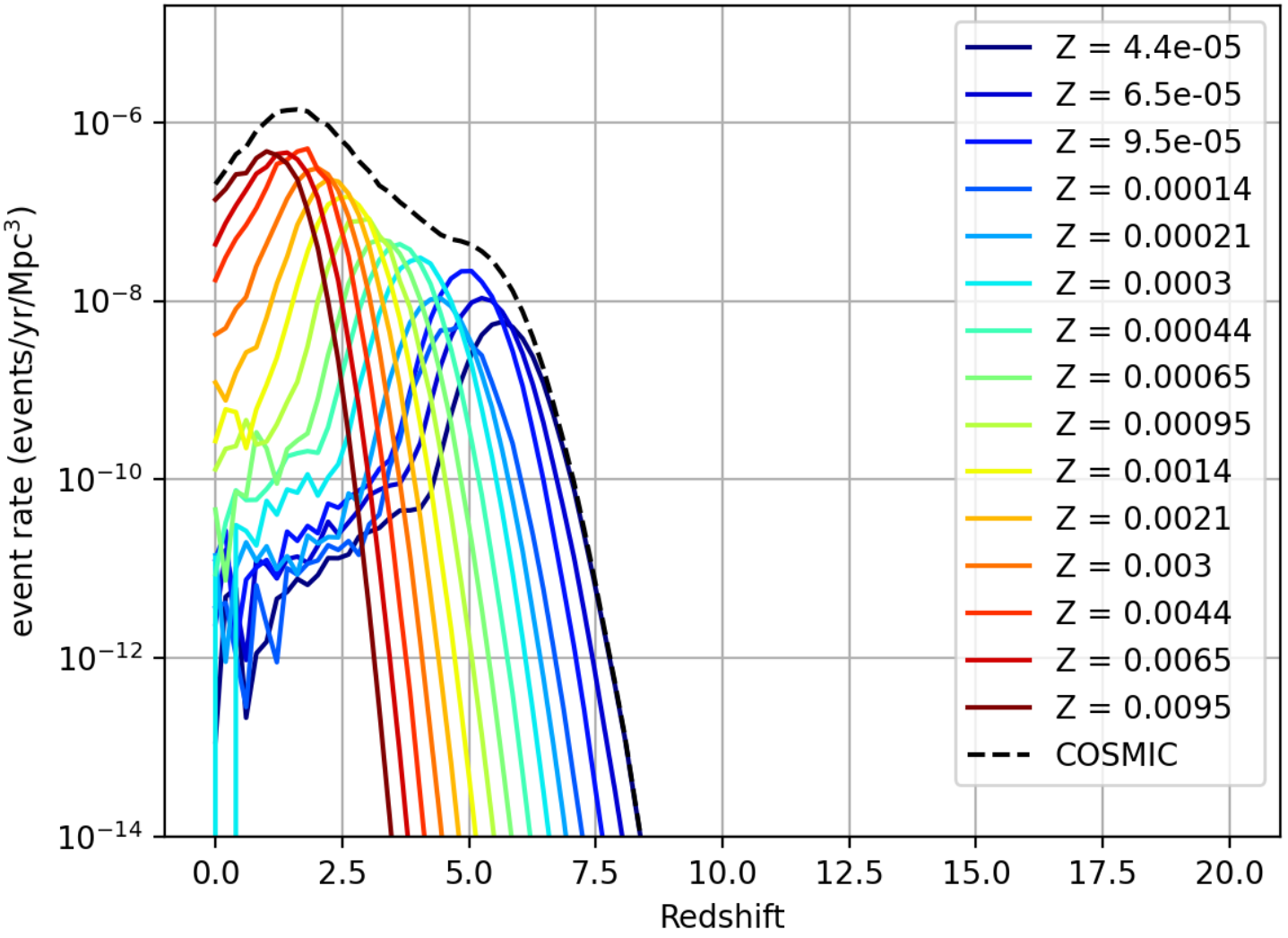

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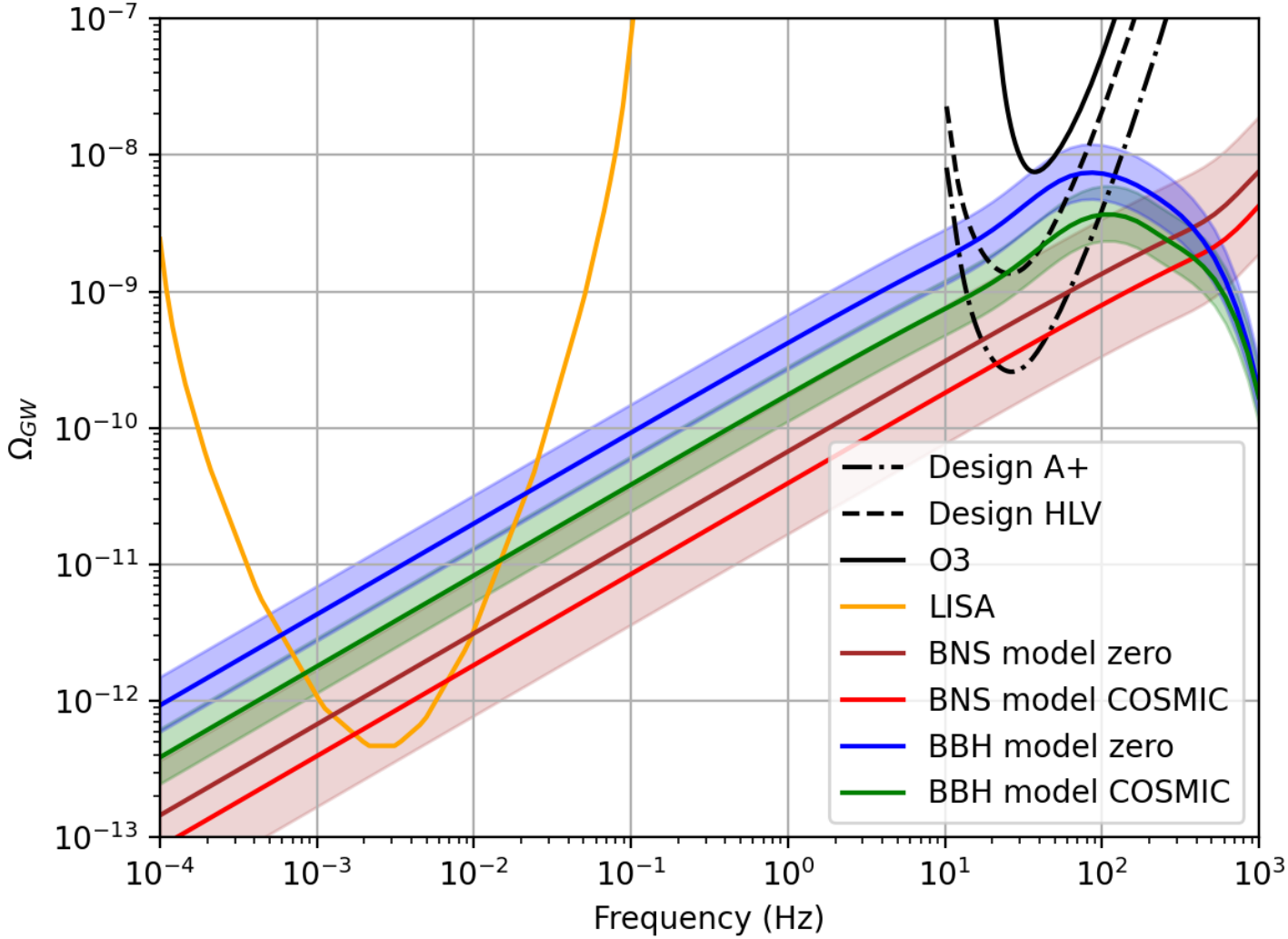
SGWB comparison - BNS



Pellouin, Dvorkin, Lehoucq in prep

Conclusion

- We identified the sources of uncertainties of the astrophysical SGWB both for BBHs and BNS.
- We find that some of the models could be constrained with upcoming observations.
- A few BBHs mergers might be detectable by LISA.