Impact of populations of BBHs on the astrophysical background in 3G detectors

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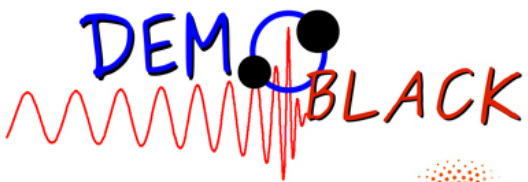

Gravitational wave background

Definition

Signal made by the sum of all non-identified gravitational waves.

Origine

- Astrophysical: CBCs, rotating neutron stars...
- Cosmological: Cosmic strings, Phases transition...

Spectrum

$$\Omega_{gw}(f) = \frac{1}{\rho_c}\frac{d\rho_{GW}}{\mathrm{dln}f}$$

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$$\Omega_{gw}(f) = \frac{f}{c\rho_c}\phi(f), \tag{1}$$

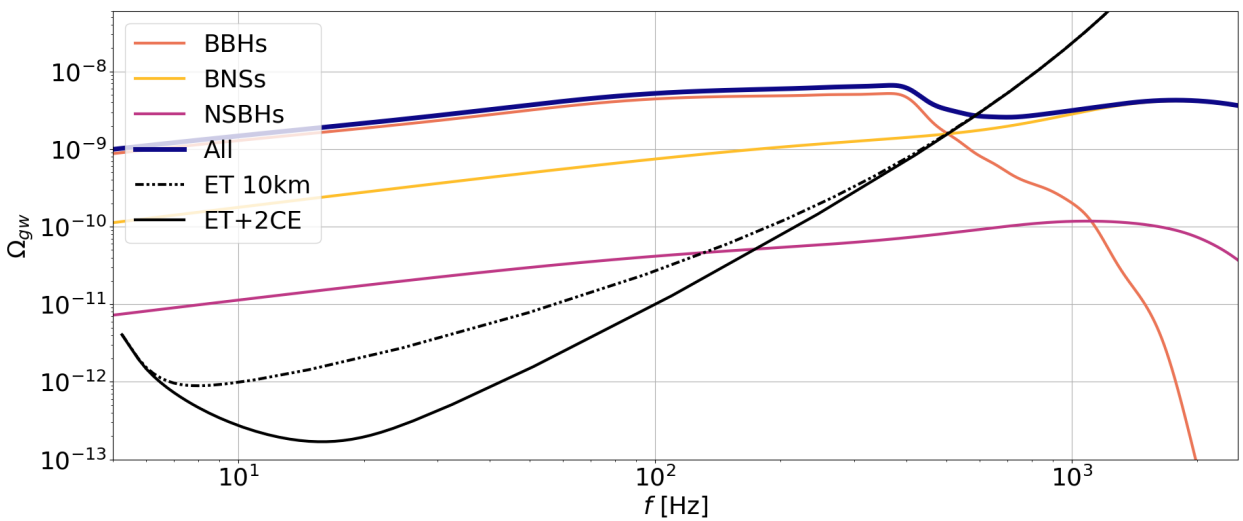
$$\phi(f) = T^{-1}\sum_{k=1}^{N}\frac{1}{4\pi r^2}\frac{dE_{gw}^{k}}{df}(f, \mathcal{M}_c, dl), \tag{2}$$

Background predictions

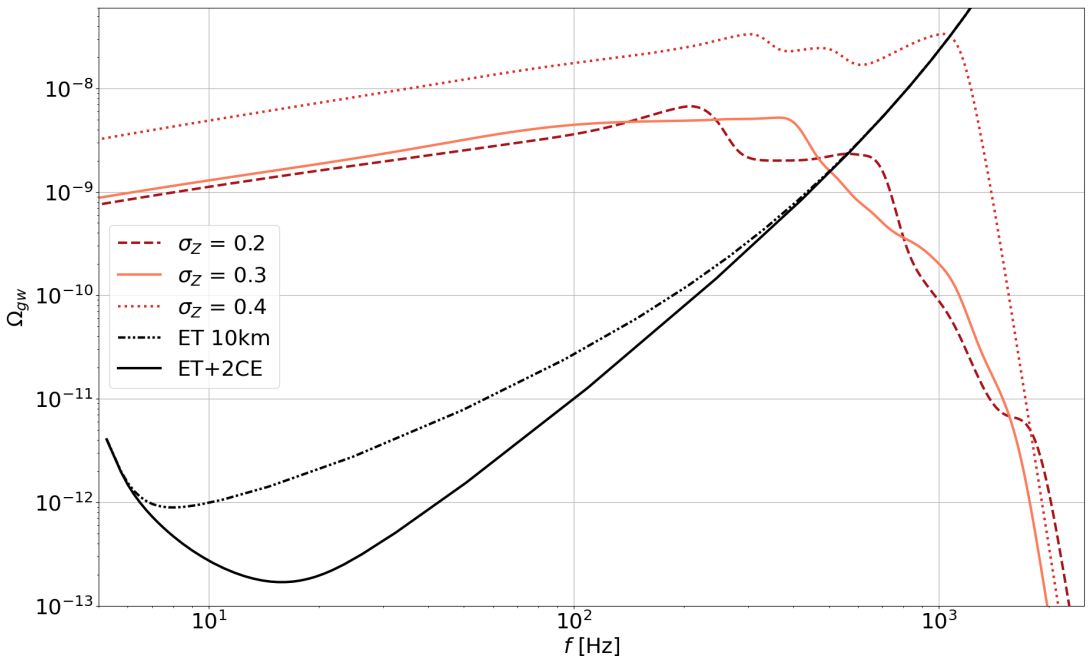
Population

Santoliquido et al. 2021, MNRAS
Mapelli et al. 2021, MNRAS
Mapelli et al. 2022, MNRAS

- **BNSs BHNSs:** Isolated, σ_Z =0.3
- **BBHs:** Isolated AND Clusters, σ_Z =0.3



Formation and evolution channel of BBHs



	$\sigma_Z = 0.2$	$\sigma_Z = 0.3$	$\sigma_Z = 0.4$
Isolated	7.41	24.66	77.75
YSC	3.10	6.07	11.93
GC	5.62	6.97	8.47
NSC	2.08	2.15	2.22

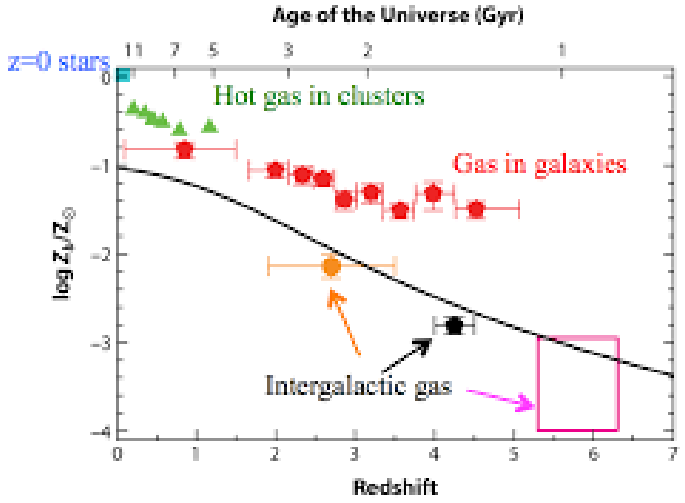
←

(TOP)Energy density spectrums for BBHs.
(BOTTOM)Local merger rate densities for BBHs channels [$Gpc^3.yr^-1$].

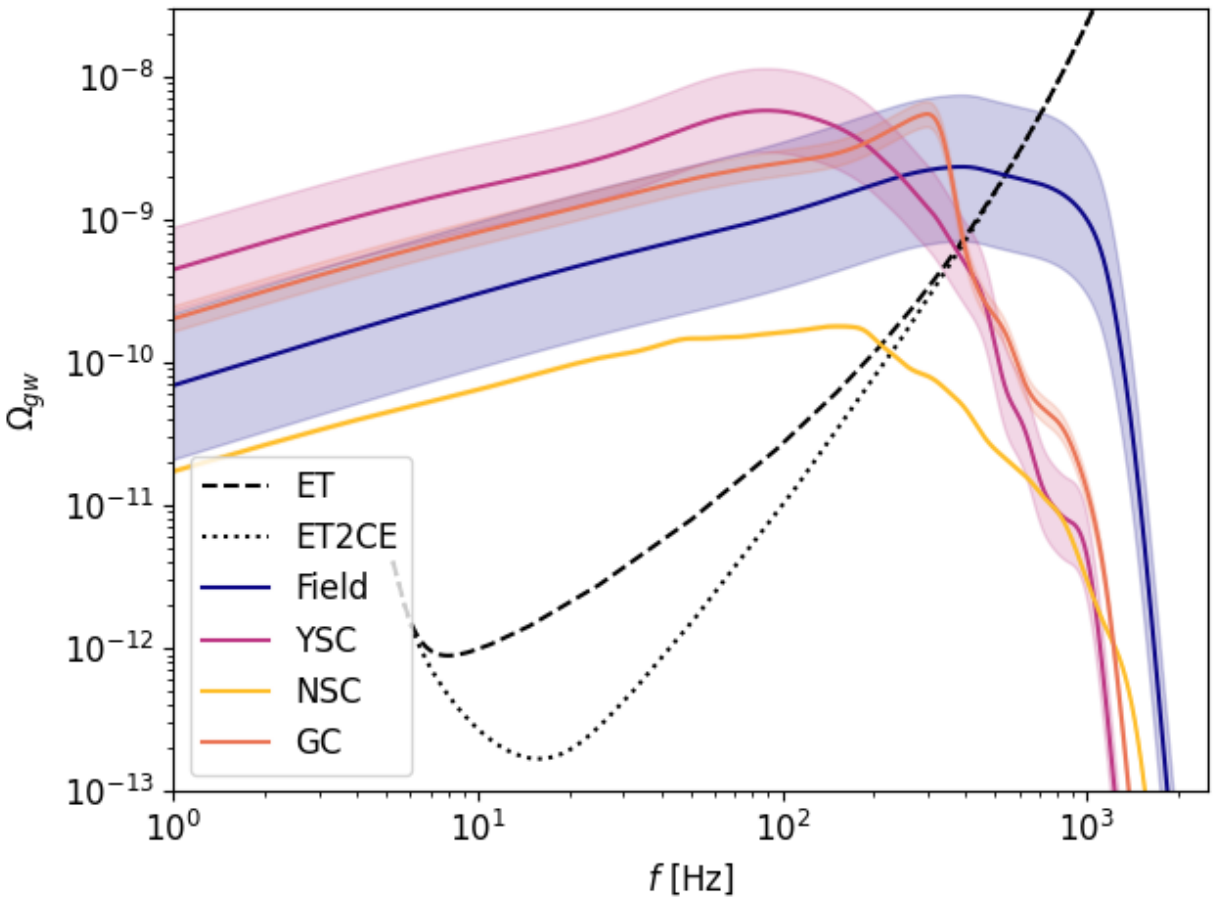
Mapelli et al. 2022, MNRAS

↓ Relation metallicity/redshift used to initiate population synthesis.

Madau and Dikinson, 2014, ARAA



BBHs from clusters PRELIMINARY

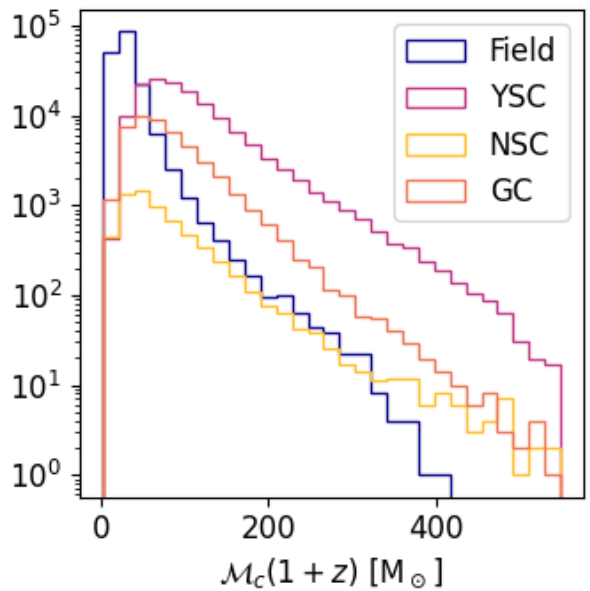


←

Spectrums for BBHs from clusters. Uncertainties are from the rates from

Mapelli et al. 2022, MNRAS

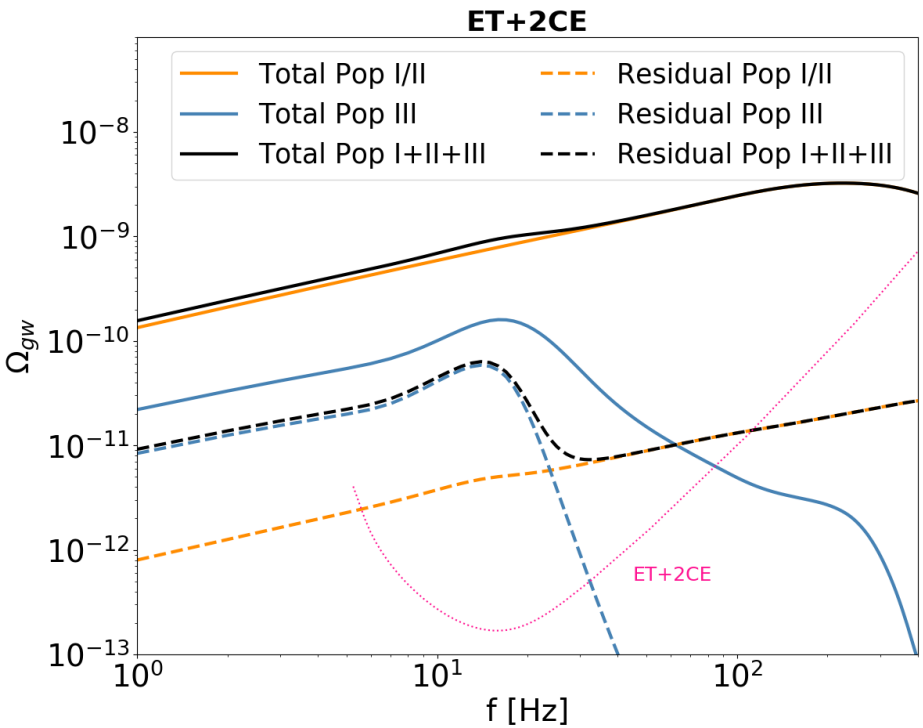
↓ Corrected mass chirp distributions in yr^{-1}.



Population III in 3G detectors

Périgois et al. 2021, Phys. Rev. D 103, 043002

Martinovic et al. 2021, arXiv: [2109.09779]



Population III

Belczynski et al. 2017, MNRAS

- Zero metallicity
- $\mathcal{R}_{max}$ at $z \sim 11$.
- $M_{\rm tot} \sim 80\ \mathrm{M}_{\odot}$

Residual Background

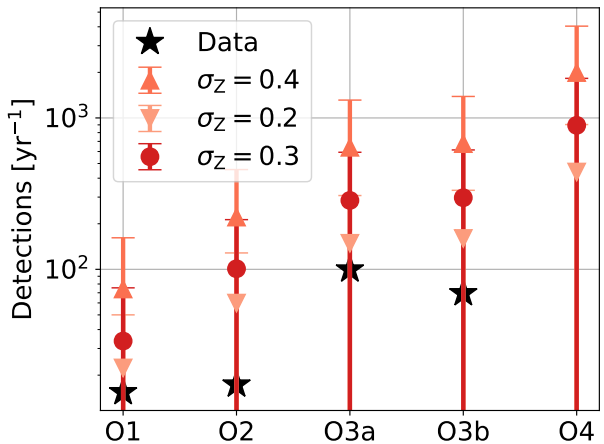
- Subtraction of mergers with SNR>12
- Important reduction for Pop. I/II
- Bump for Pop. III visible (Selection effects)

PRINCESS: A tool to predict GW observations

- Predictions of the resolved event, by computing individual SNR.
- Computation of the total and residual backgrounds.
- Calculation of the background detectability.

Ingredients :

- Detectors characteristics
- Catalog of compact object binaries



	$\sigma_Z = 0.2$	$\sigma_Z = 0.3$	$\sigma_Z = 0.4$
ET	61570 (76.2%)	93545 (79.0%)	145867 (81.5%)
2CE	78598 (97.3%)	115714 (97.7%)	175428 (98.0%)
ET+2CE	80074 (99.1%)	117596 (99.3%)	177906(99.5%)
Total	80762	118429	178883

https://github.com/Cperigois/Princess
https://gitlab.com/Cperigois/Princess

Take home message

Projects in progress or planned for 2024:

- AGNs and GCs mergers.
- PRINCESS developpement detectors (LISA, PTA) and sources (SMBHs, EMRIs)
- Updating Pop III with new simulations.

The interest on the astrophysical background is double

- We would like to extract all possible astrophysical informations.
- And we would like to remove it to show other possible contribution to the background.