Around unavoidable processes in the early universe

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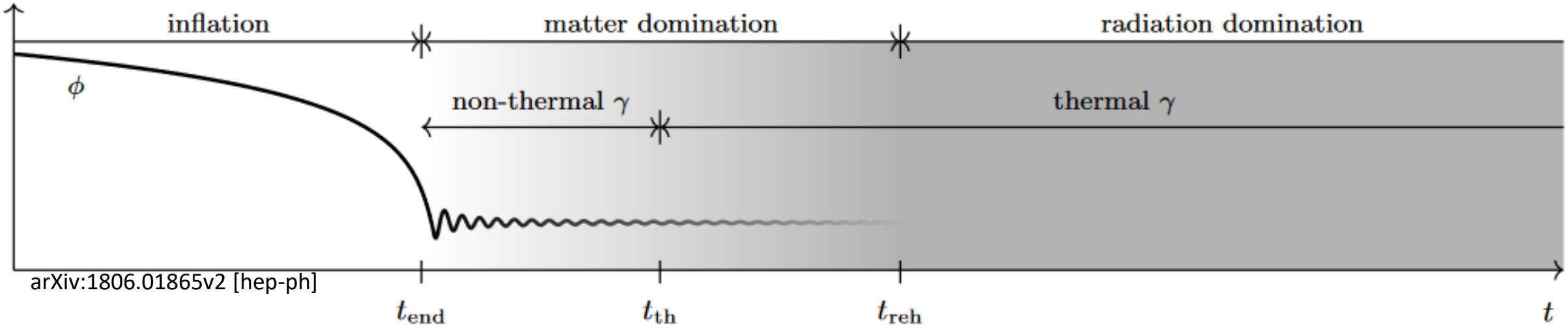
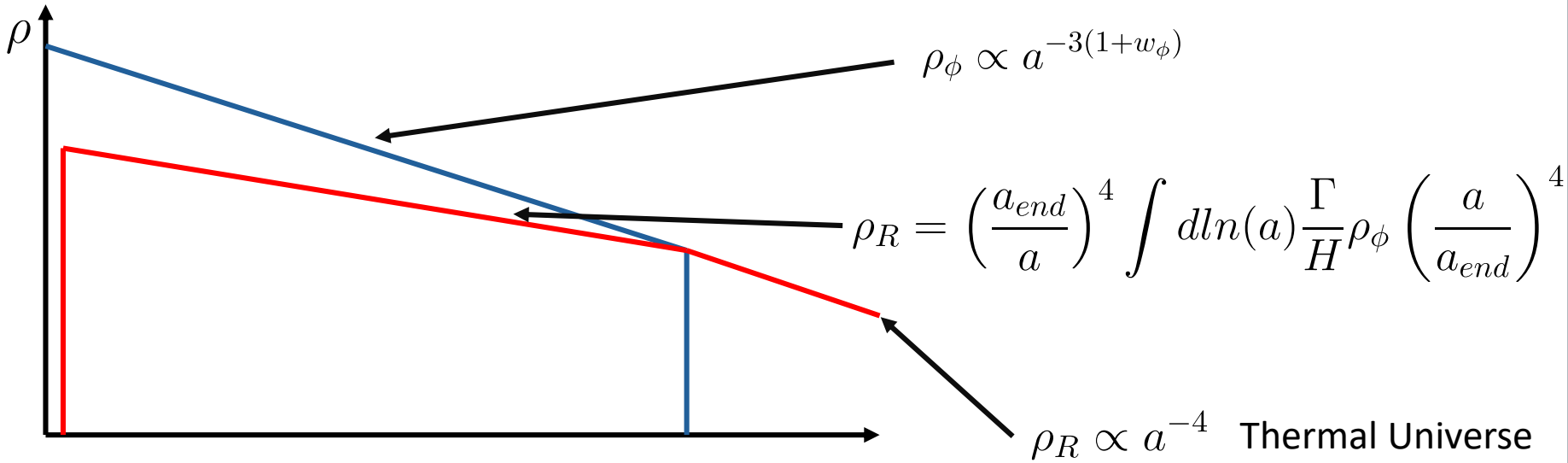
Collaboration project with: Mathias Pierre from DESY

Short reminder of perturbative reheating



arXiv:1806.01865v2 [hep-ph]

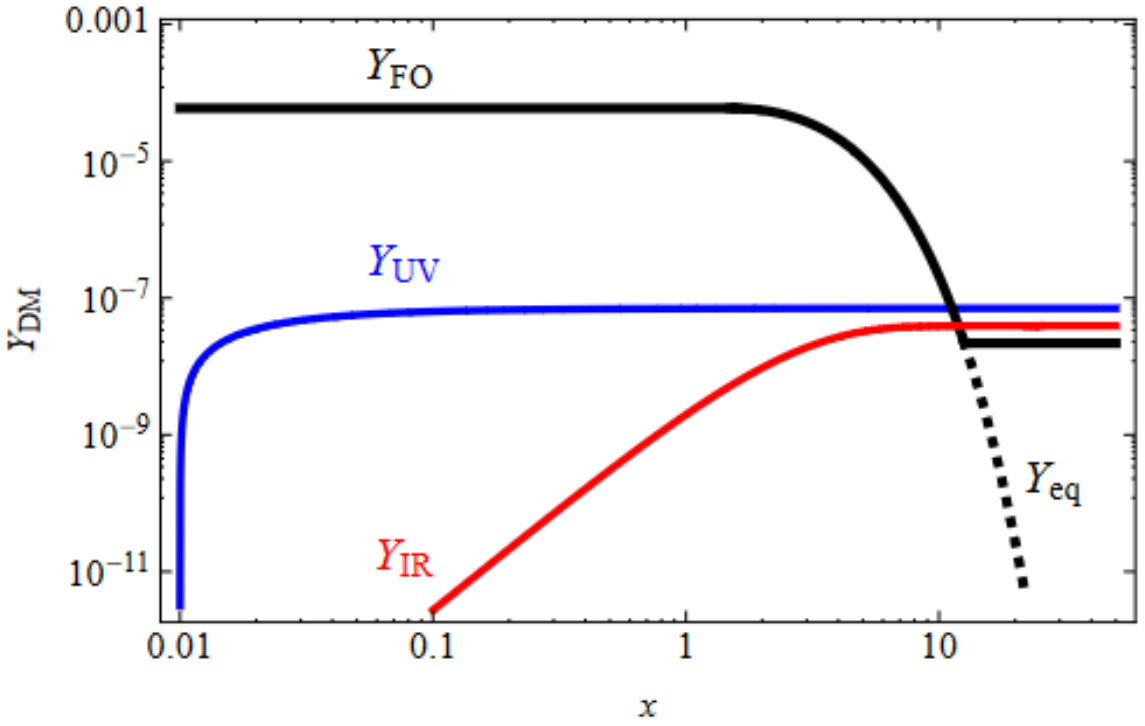


Inflaton

radiation

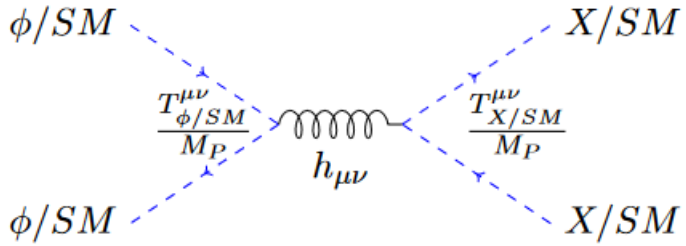
Why is reheating important?

- Trh is an important parameter:



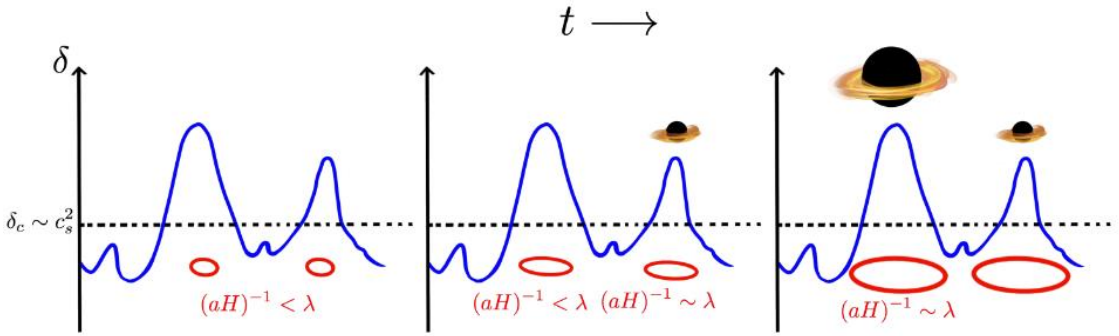
arXiv:1410.6157 [hep-ph]

Reaheating leave space for other processes:
-Dark matter production:



arXiv:2112.15214 [hep-ph]

- Primodial Black Holes:



arXiv:2103.12087 [astro-ph.CO]

Example of minimal/unavoidable processes

- Primordial Black hole evaporation

arXiv:2107.00013 [hep-ph]

- Graviton portals

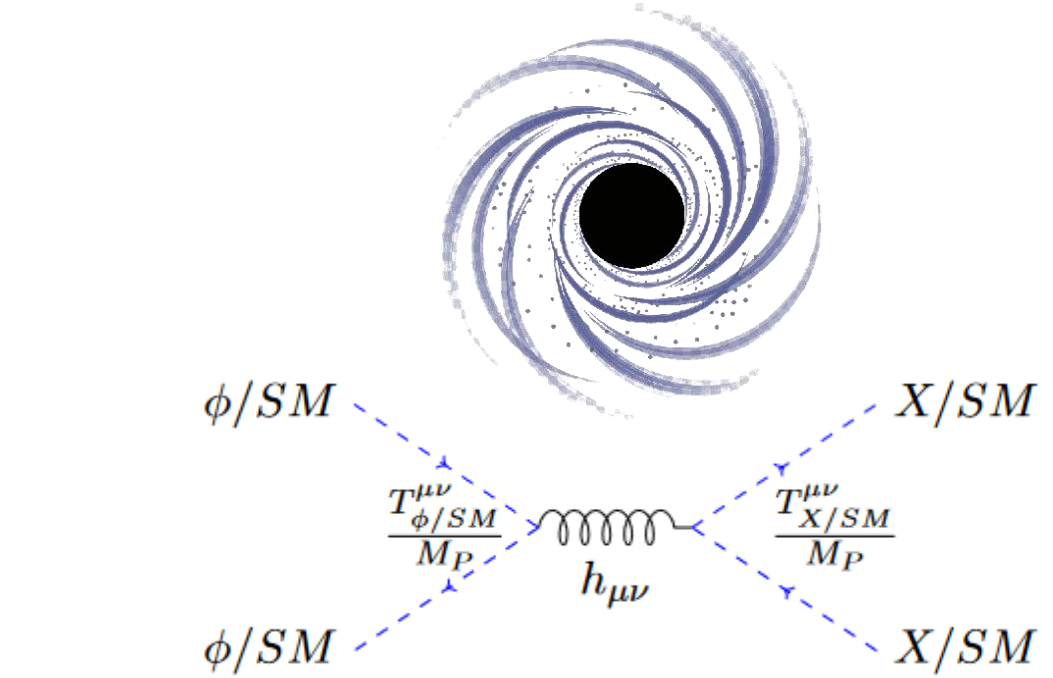
arXiv:2112.15214 [hep-ph]

- GW production from the thermal bath

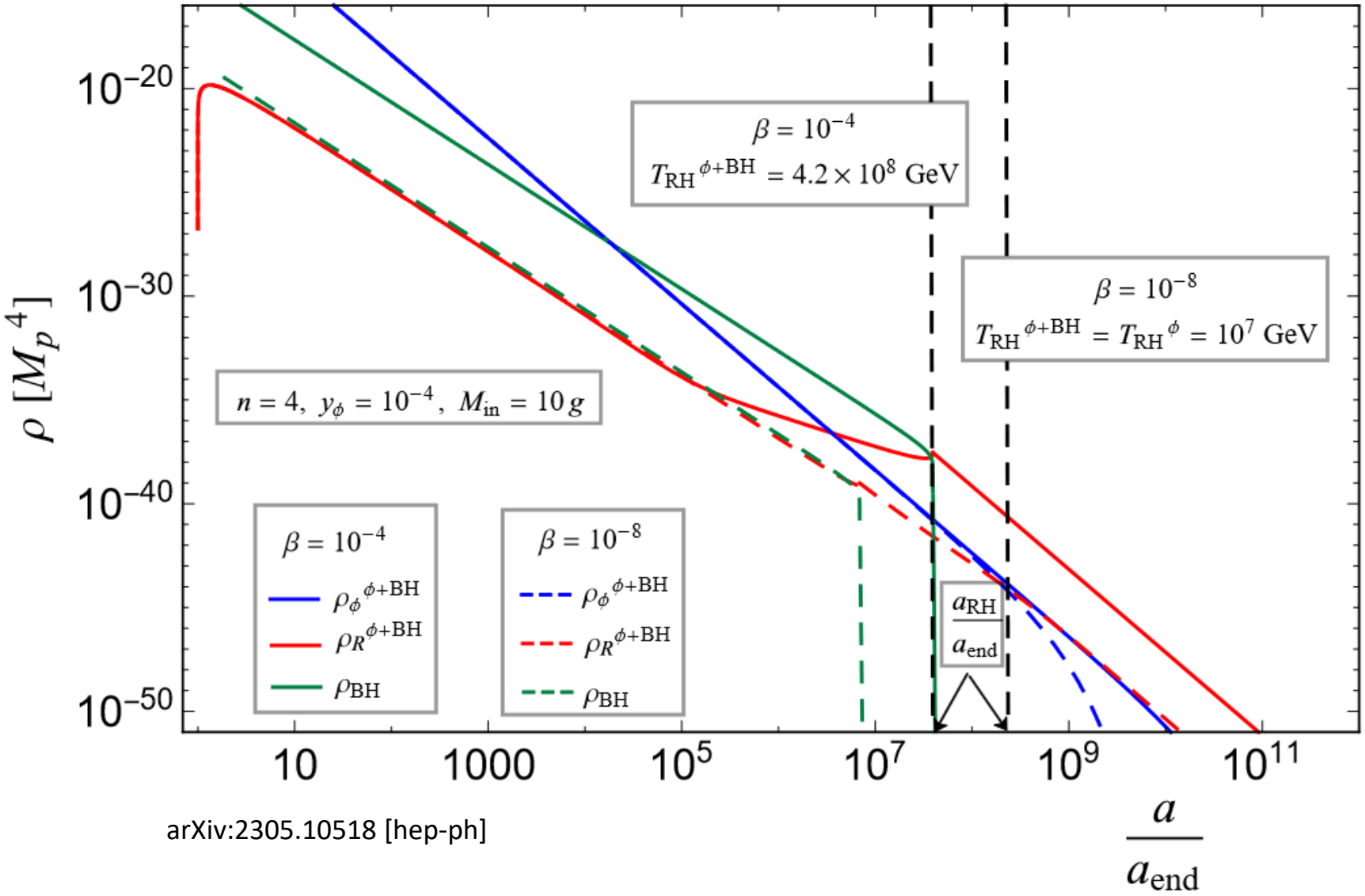
arXiv:2401.08766 [hep-ph]

- GW production from inflaton decay

arXiv:2402.04310 [hep-ph]

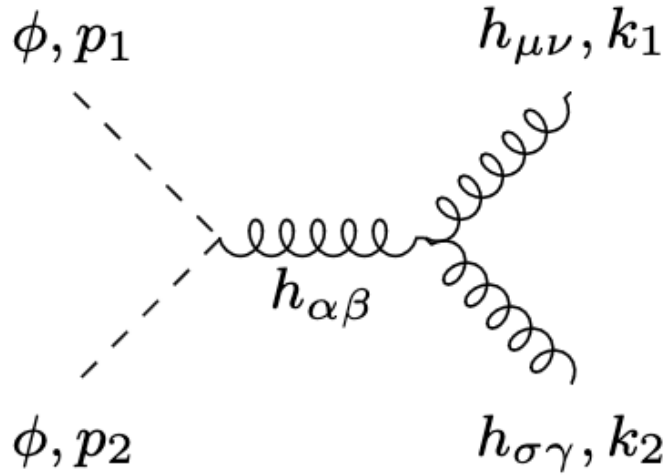


PBH domination Scenario



arXiv:2305.10518 [hep-ph]

GW sources

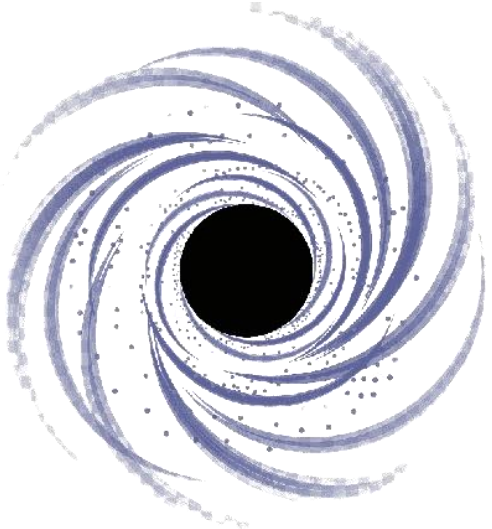


GREFT:

$$\mathcal{L} \supset \frac{1}{M_{pl}} h_{\mu\nu} T^{\mu\nu} + O(h^3)$$

arXiv:2402.04310 [hep-ph]

2



3

Hawking evaporation:

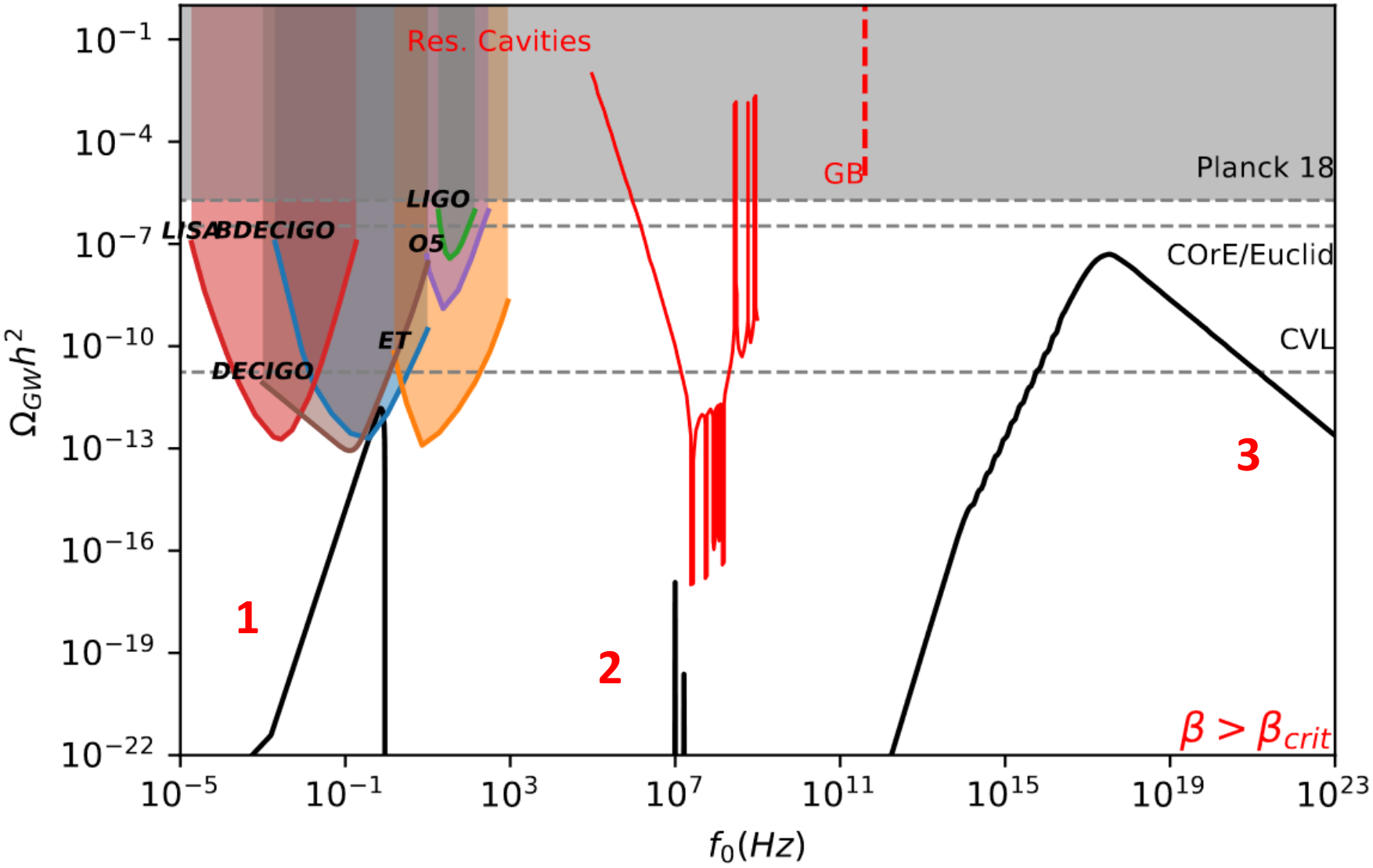
$$\frac{d^2 N_g}{dt dE} = \frac{1}{2\pi} \frac{\Gamma(M, s_g)}{e^{E/T_{BH}} - 1} \qquad T_{BH} = \frac{M_{pl}^2}{M}$$

Cosmological fluctutations:

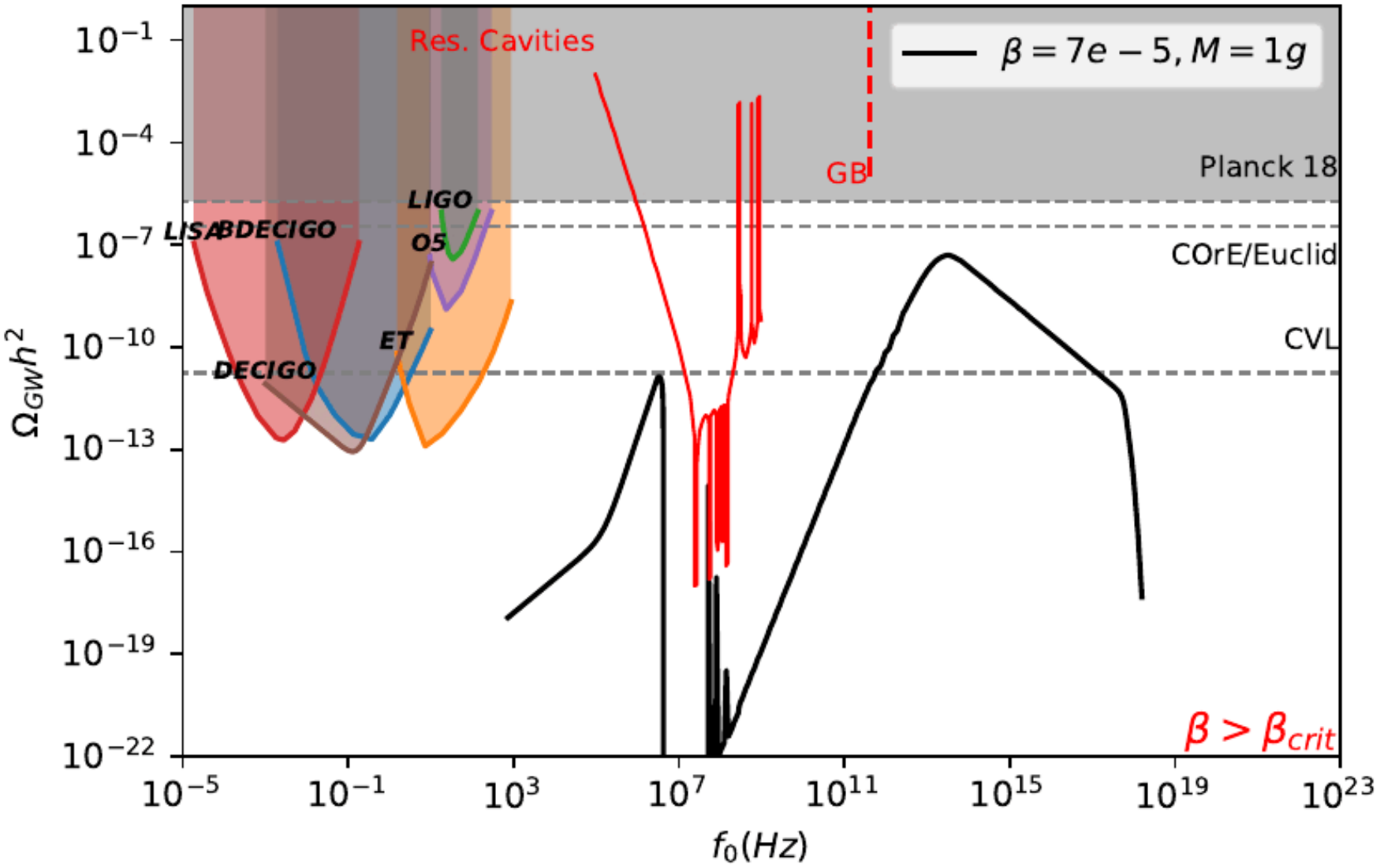
arXiv:2409.12125 [gr-qc]

1

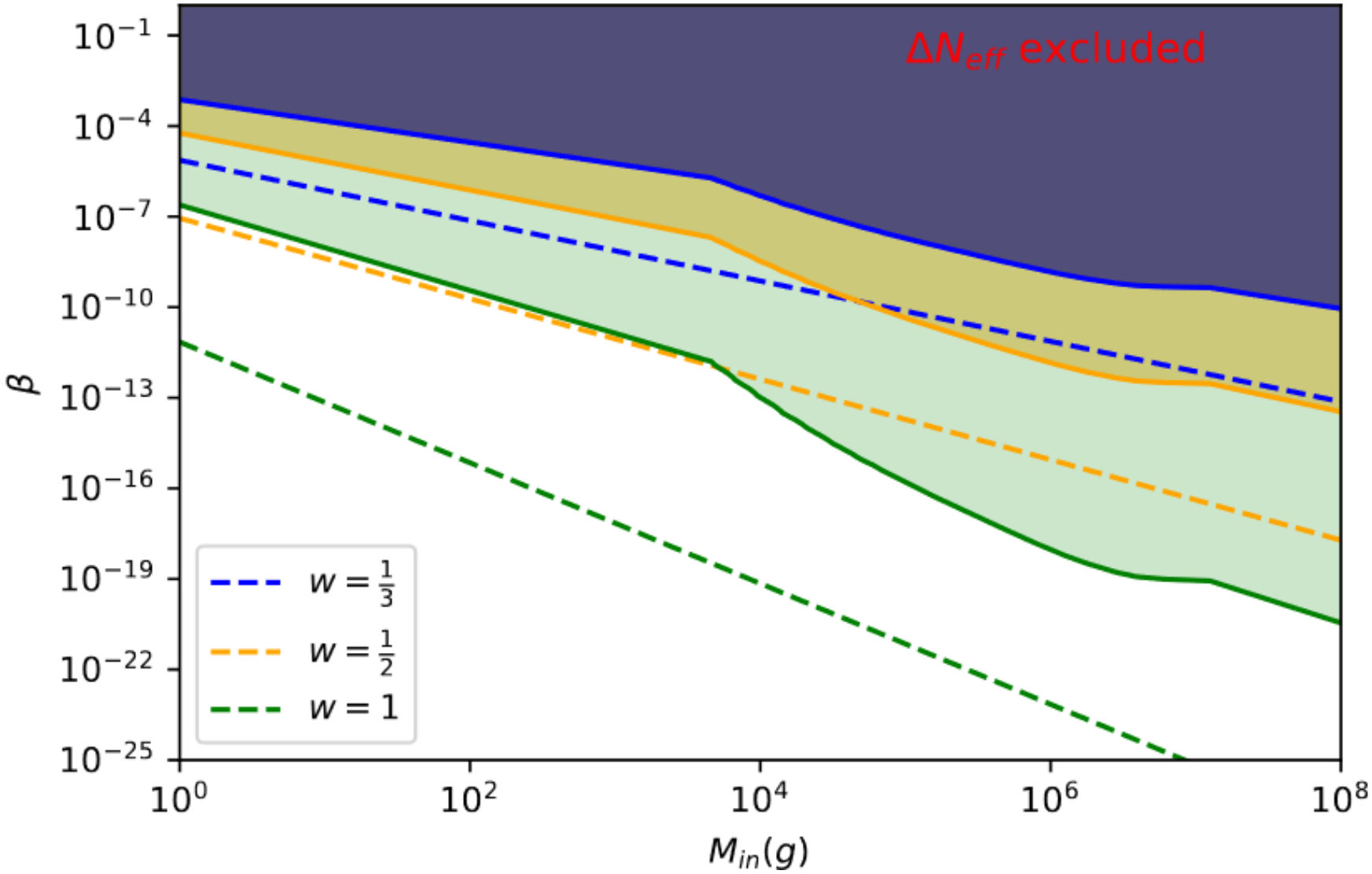
Minimal GW spectra if PBH dominates w=1/3



Minimal GW spectra if PBH dominates w=1/3



Future constraints on this scenario if we see nothing



Conclusion

-Gravity offers a minimal framework for early universe production mechanism.

-Those processes need to be studied in a more systematic manner.

-Further work:

- -Distribution effect of the PBH
- -Link with inflation and production
- -Minimal prcesses linked with new particle physics.