

Cosmological stochastic backgrounds: slides for the discussion

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Summary

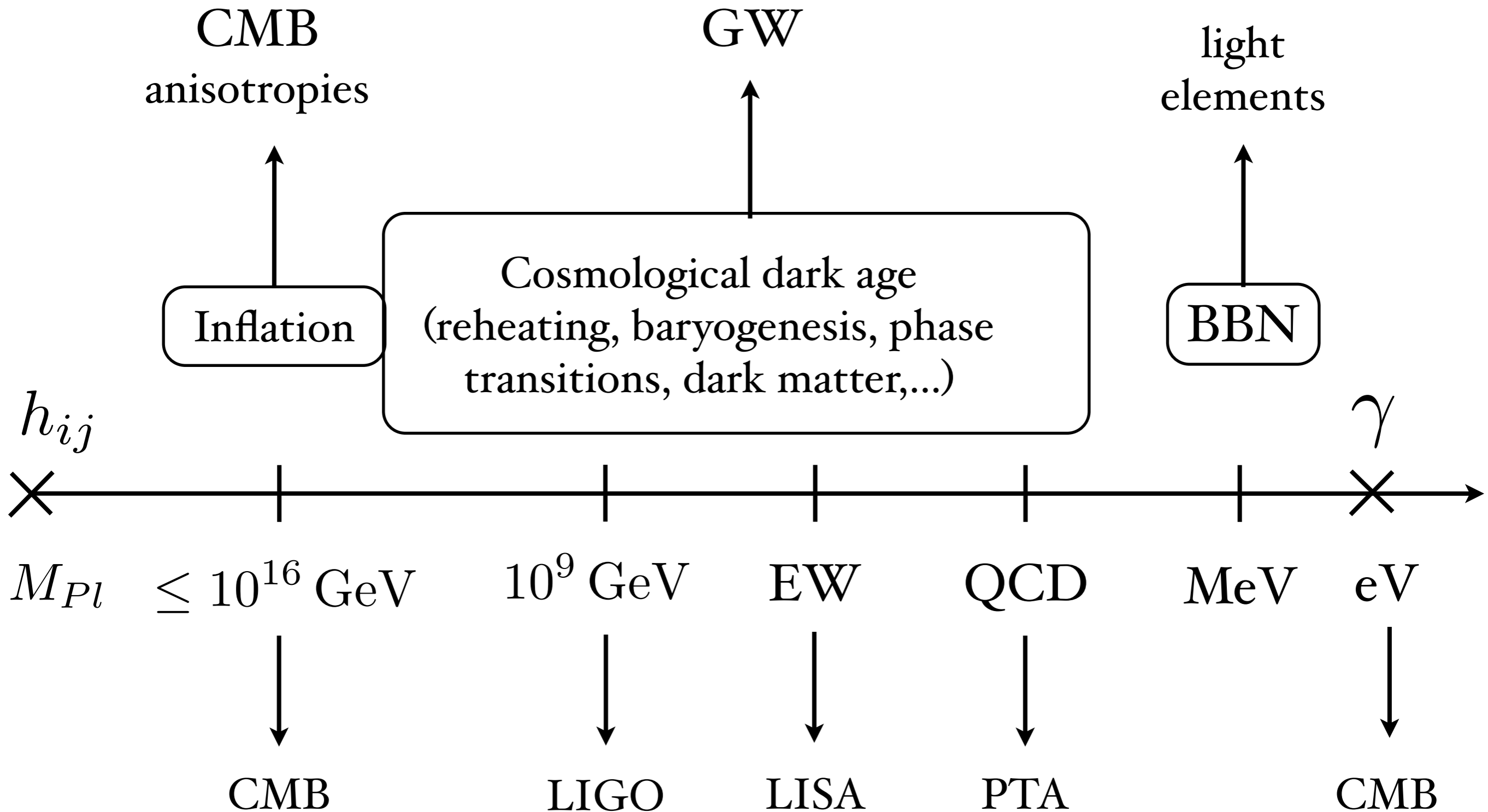
- a SGWB could be produced from processes operating in the very early universe
- the amazing thing: because of the weakness of the gravitational interaction, one can in principle detect the signal arising *from epochs much before the decoupling of photons (CMB)*
- this provides access to physics *beyond the standard model of particle physics* to which we have no access so far
- however, because of this, we don't know which processes may have operated to produce GWs at those early epochs
- current predictions on the SGWB from the early universe are uncertain and based on speculations about generating processes
- it is a *discovery space, no guaranteed source*

Summary

- there are a variety of predictions in terms of amplitude and spectral shape of the SGWB from cosmological sources (see examples later on)
- in order to be able to identify the source and claim a detection it is fundamental to:
 1. characterise the *spectral shape* with the measurement
 2. characterise all *astrophysical foregrounds*
 3. characterise the *noise of the detector*
- very ambitious task, but in the end *it all depends on the SNR of the SGWB*

because of the weakness of the gravitational interaction the universe is transparent to GW

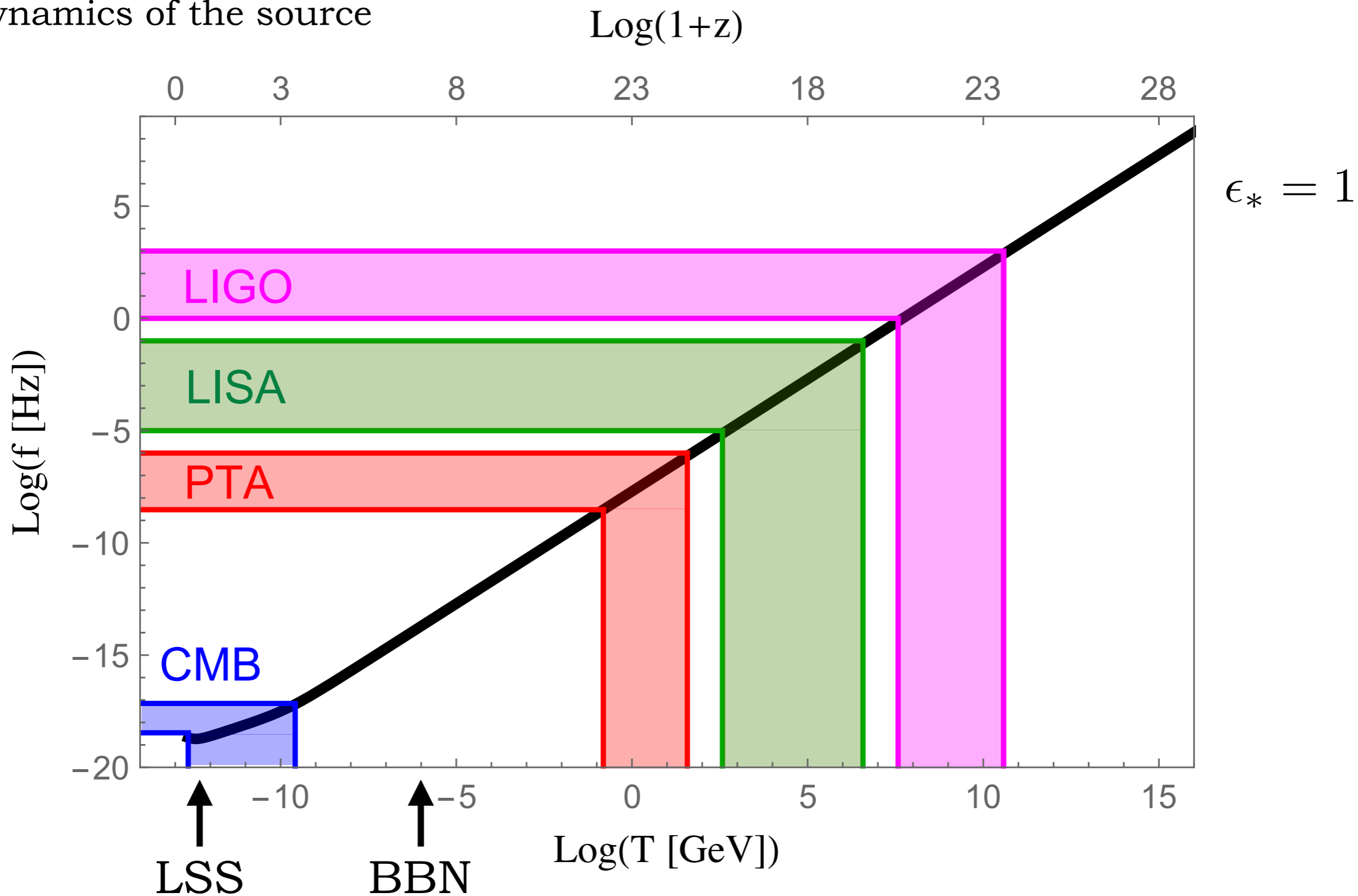
$$\frac{\Gamma(T)}{H(T)} \sim \frac{G^2 T^5}{T^2/M_{Pl}} \sim \left(\frac{T}{M_{Pl}}\right)^3 < 1$$



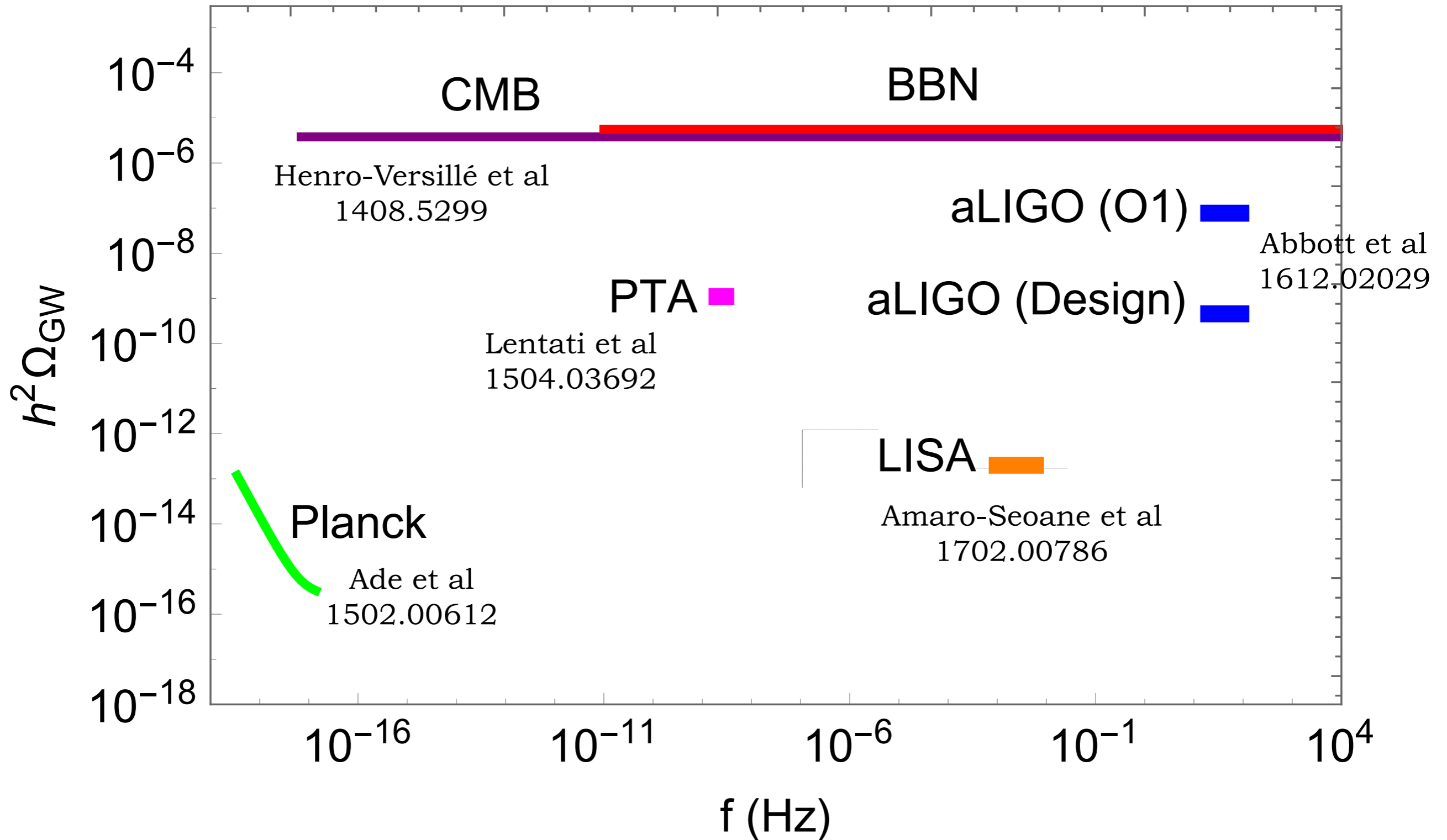
$$f_* = \frac{H(T_*)}{\epsilon_*}$$

$$f_c = f_* \frac{a_*}{a_0} = \frac{2 \cdot 10^{-5}}{\epsilon_*} \frac{T_*}{1 \text{ TeV}} \text{ Hz}$$

parameter depending on the dynamics of the source

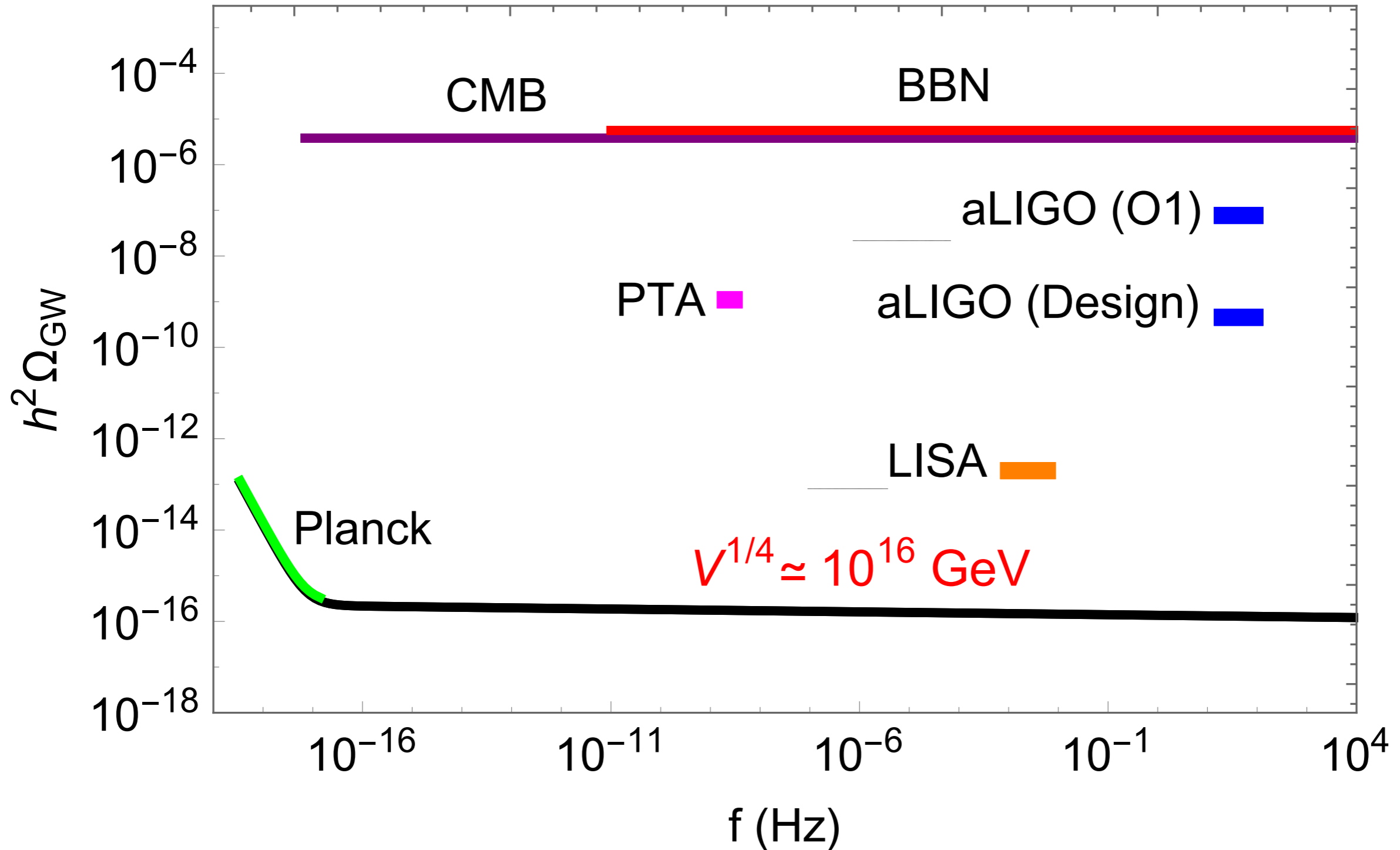


Observational bounds/sensitivities for GWSB



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signal from a *simple slow roll inflation model* :
beyond the reach of direct detection

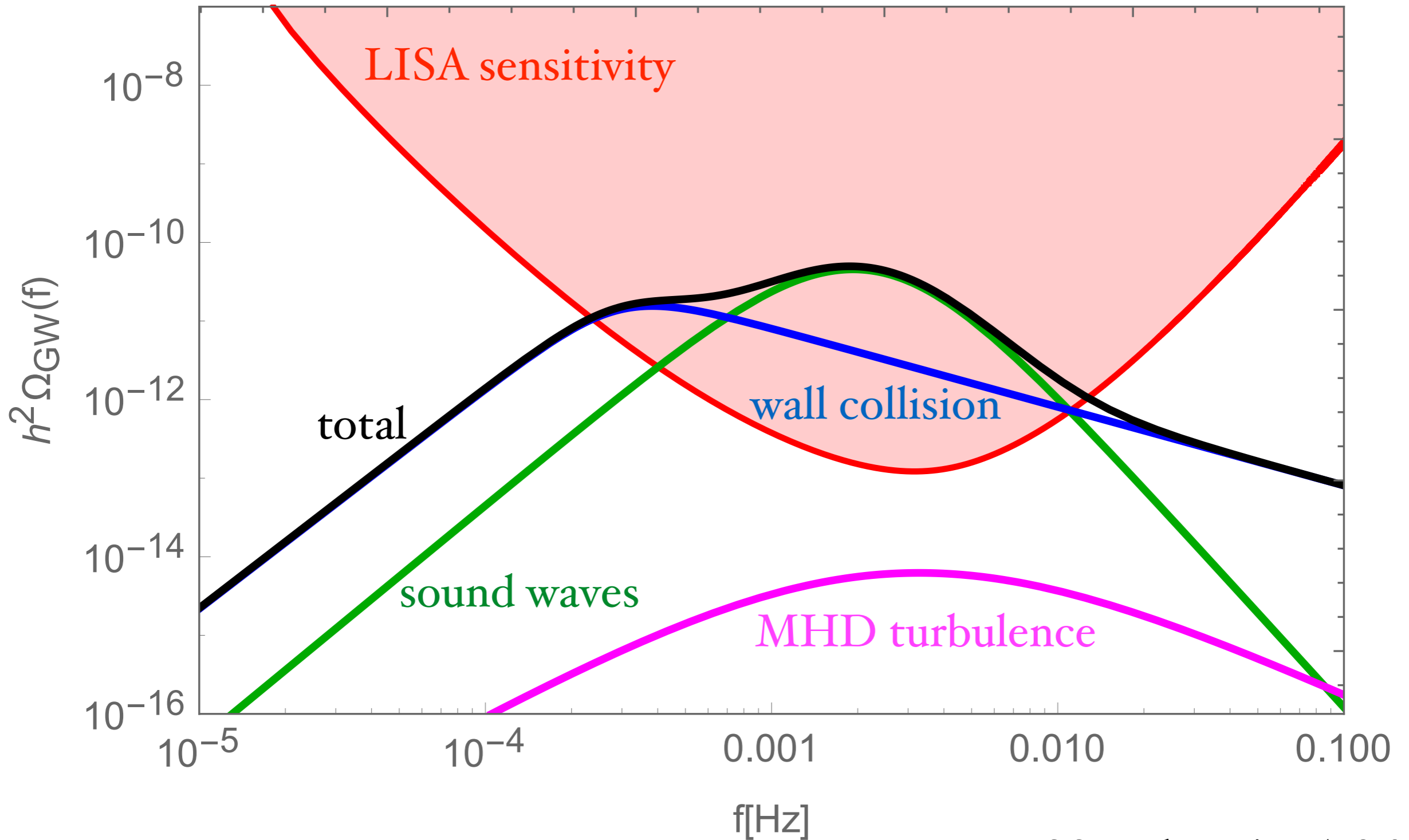


other possible sources of GW in the early universe more promising for direct detection

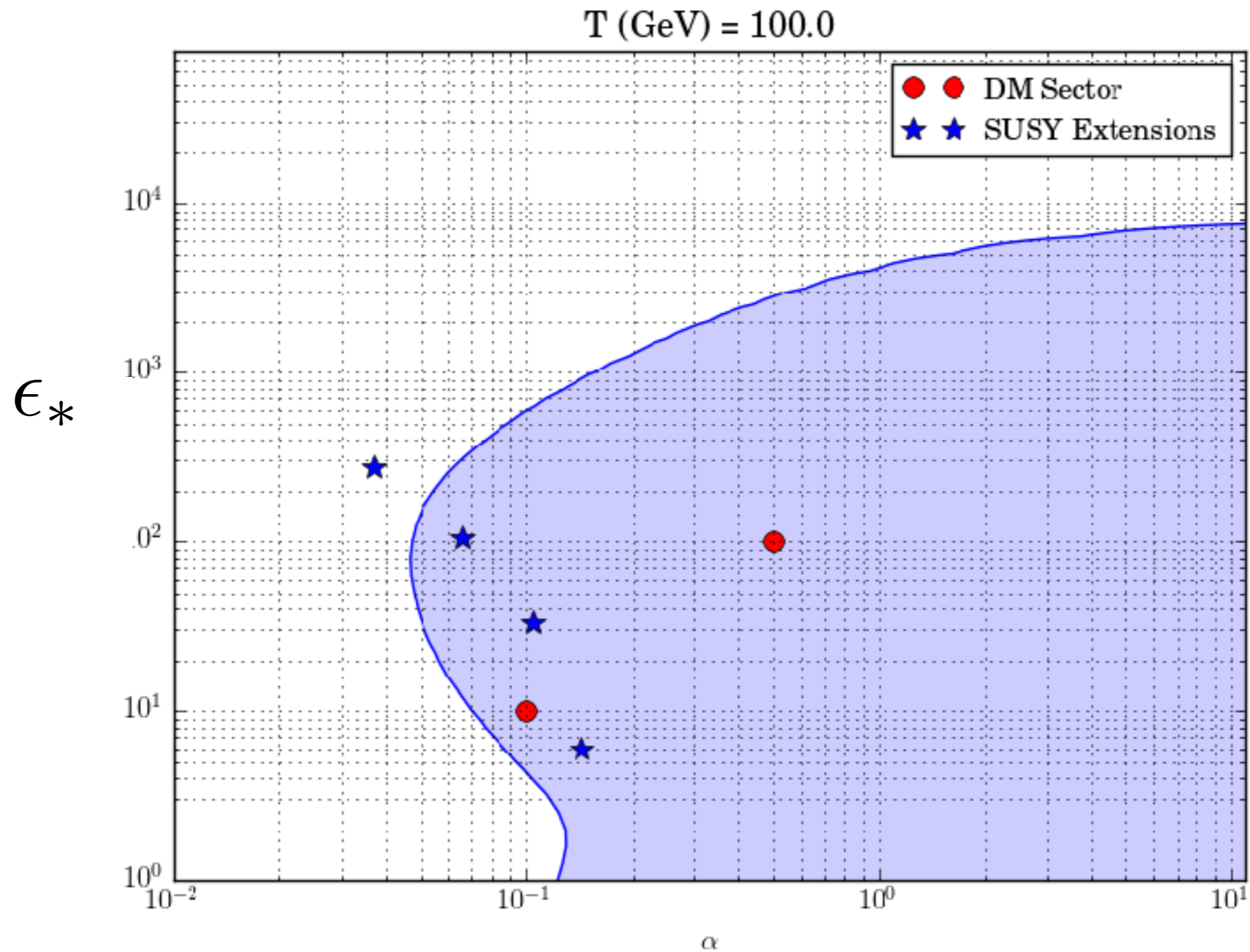
- “non-standard” inflation
 - particle production during inflation
 - fluid stiffer than radiation after inflation
 - preheating after inflation
 - phase transitions at the end or during inflation
 - ...
- first order phase transitions
- cosmic strings
- other topological defects e.g. domain walls
- primordial black holes
- scalar field self-ordering
- ...

First order phase transitions: example of signal

note the very peculiar peak structure



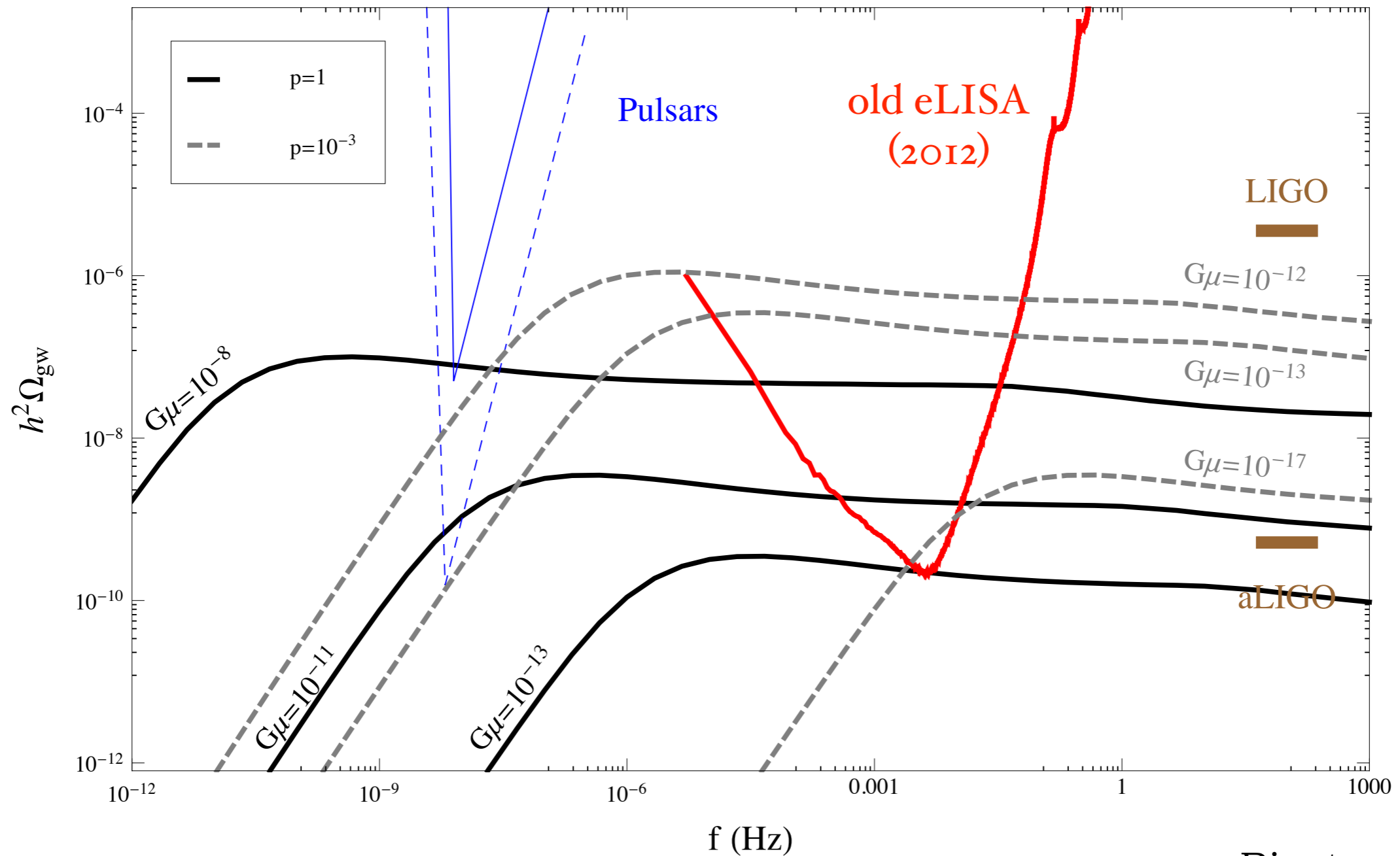
Example of detection prospects for LISA for EWPT: access to BSM physics!



strength of the PT

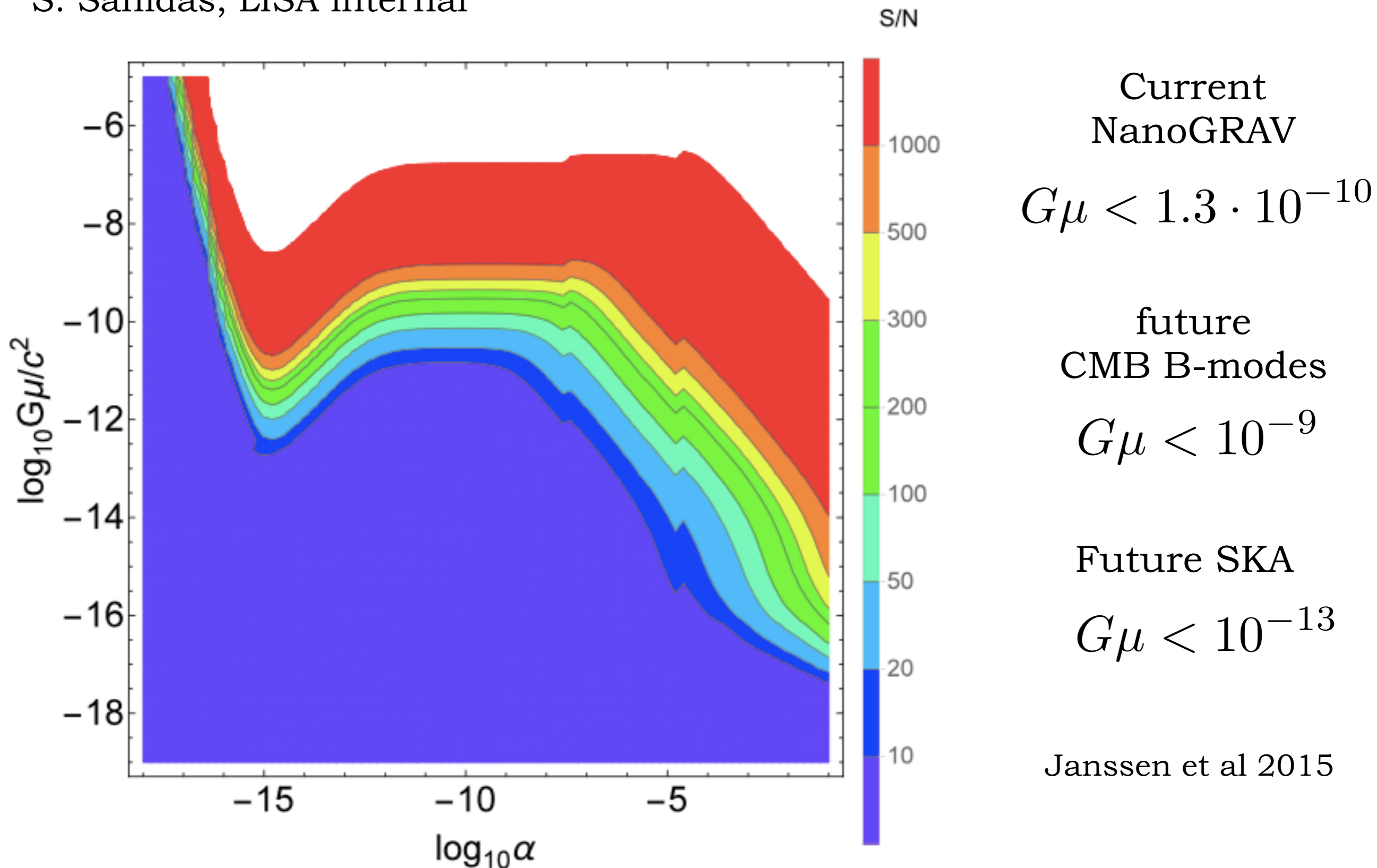
Nambu-Goto strings

- model dependent GW signal : here **large loops**
- spectral shape extended in frequency because of continuous production

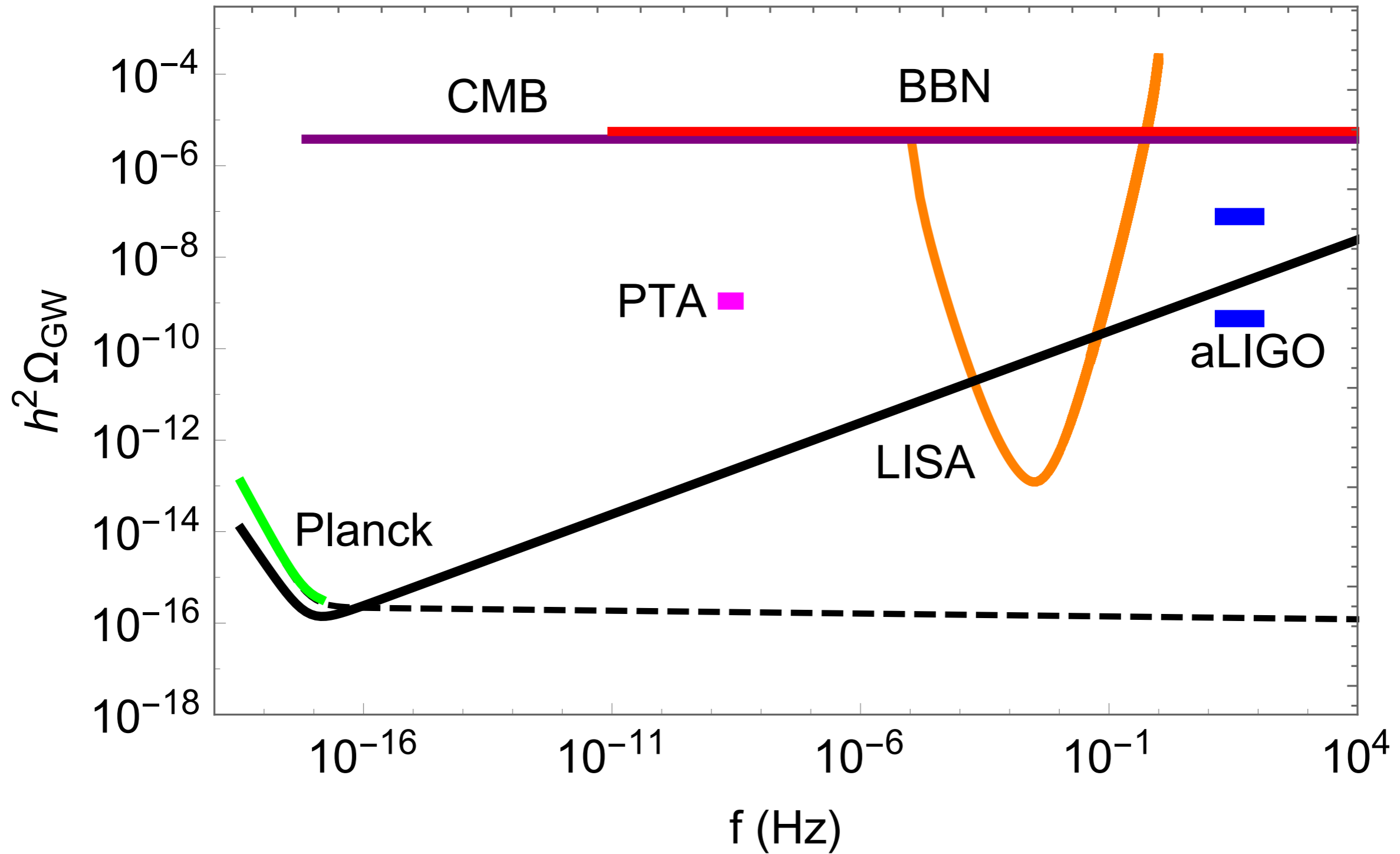


Bounds on Nambu-Goto strings, loop size

S. Sanidas, LISA internal

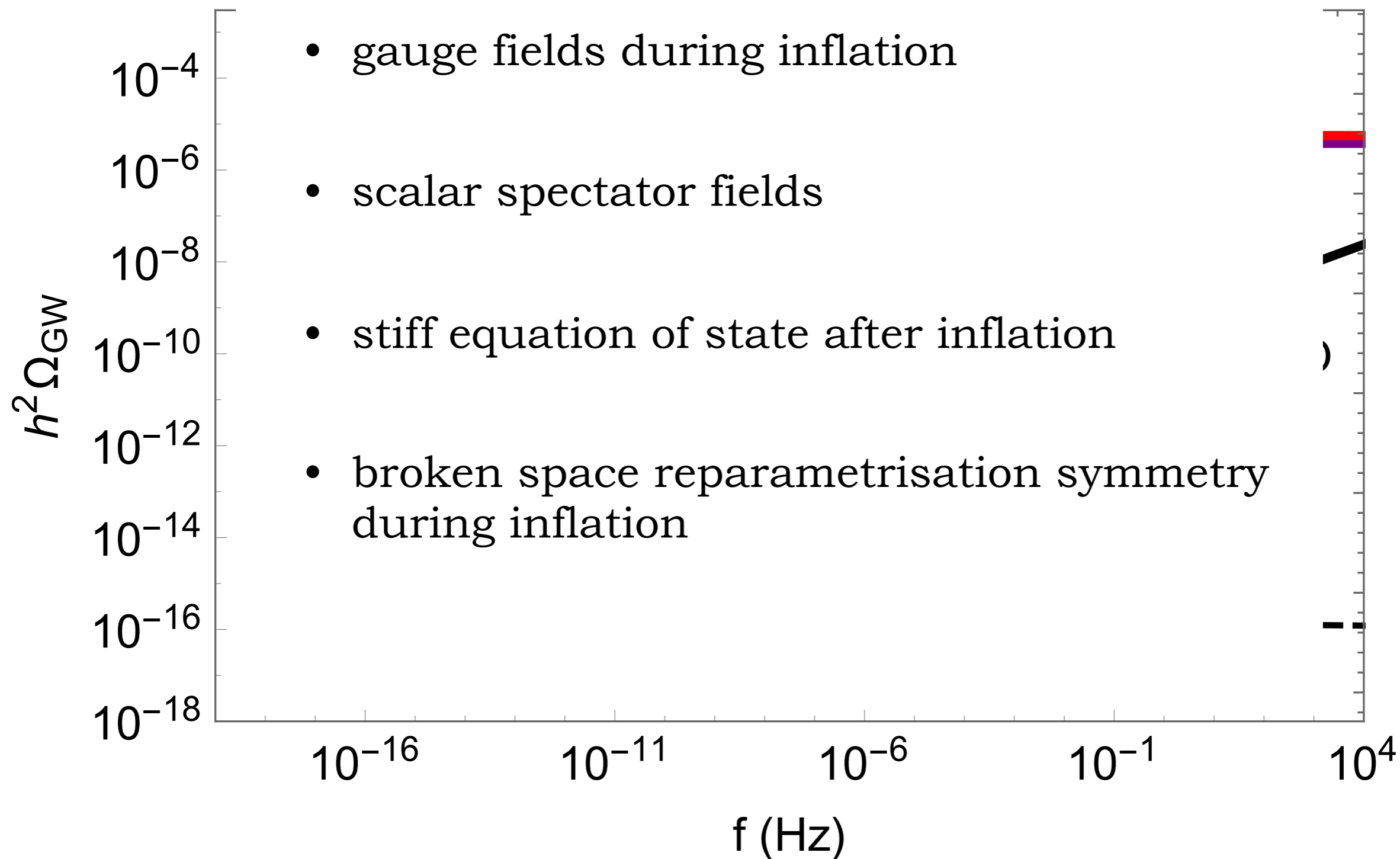


“Non-standard inflation”



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N. Bartolo et al, 1610.06481

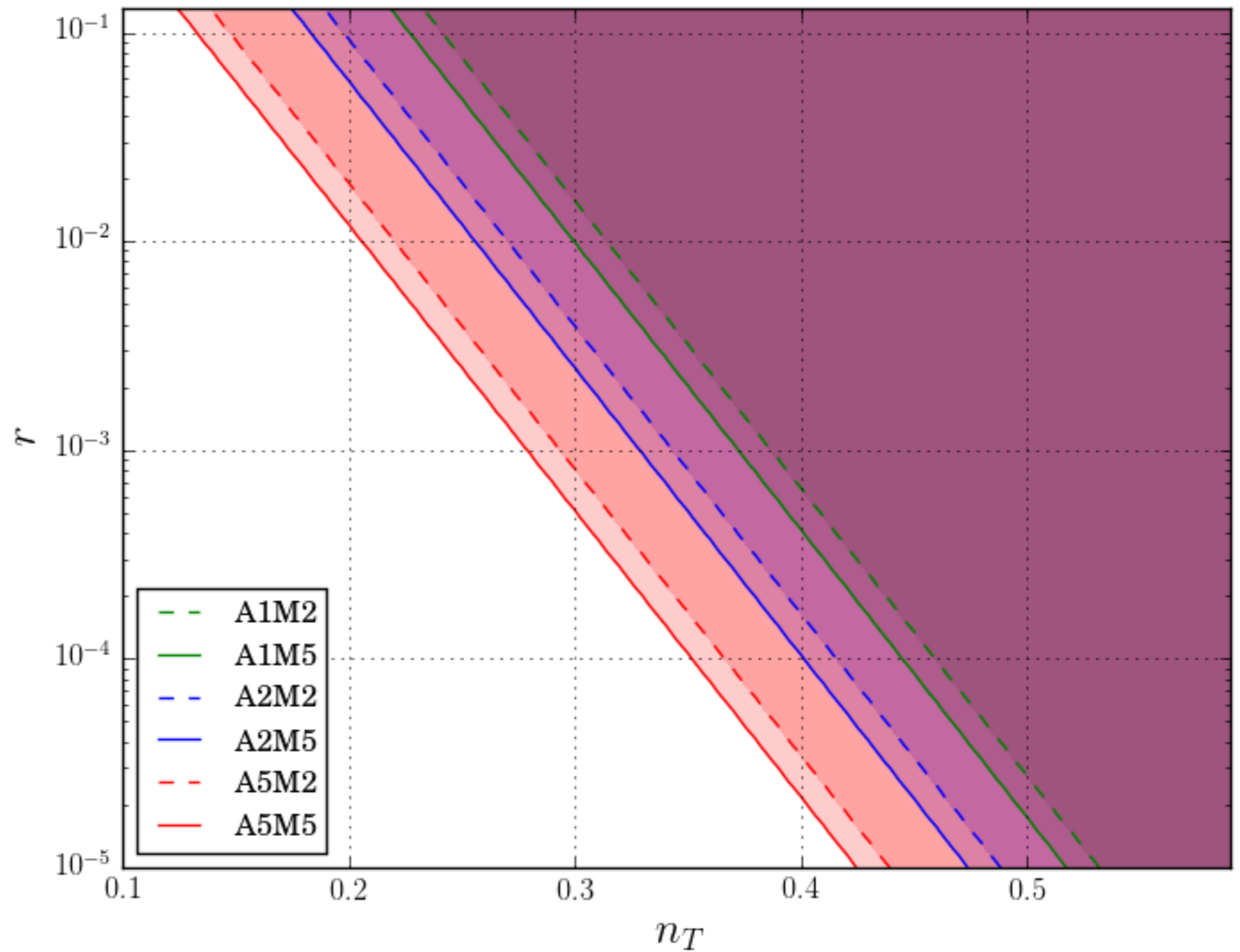


“Non-standard inflation”

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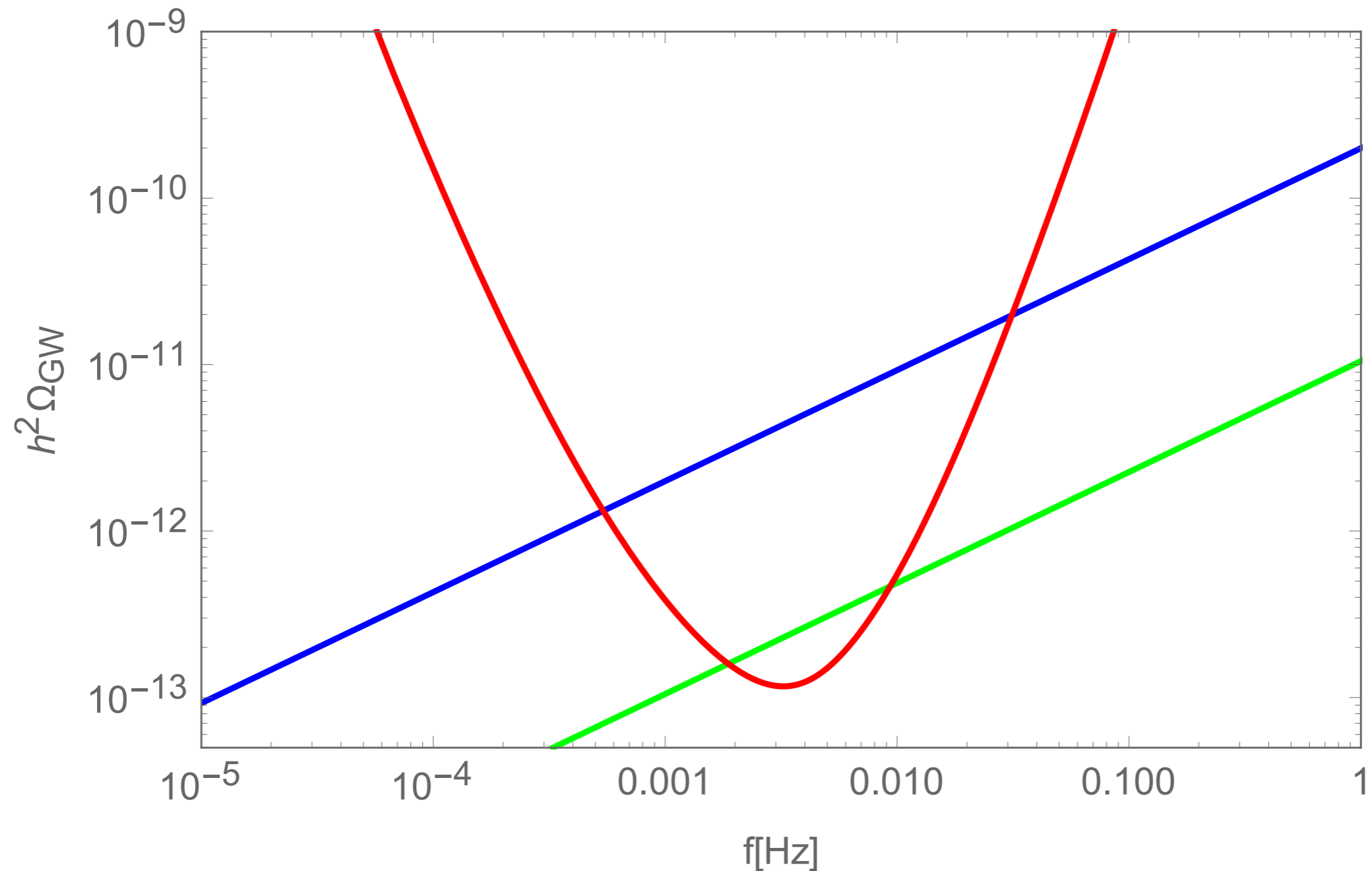
$$k_* = 0.05 \text{ Mpc}^{-1}$$

tensor to
scalar ratio



tensor spectral index

Example of foreground: GW150914-like BHB in the LISA band



levels taken from Abbott et al, 1602.03847