



Spectral Distortions from Dark Sector Anisotropies

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μ -distortions in the CMB

CMB possesses a Blackbody spectrum with $T = 2.73\text{K}$

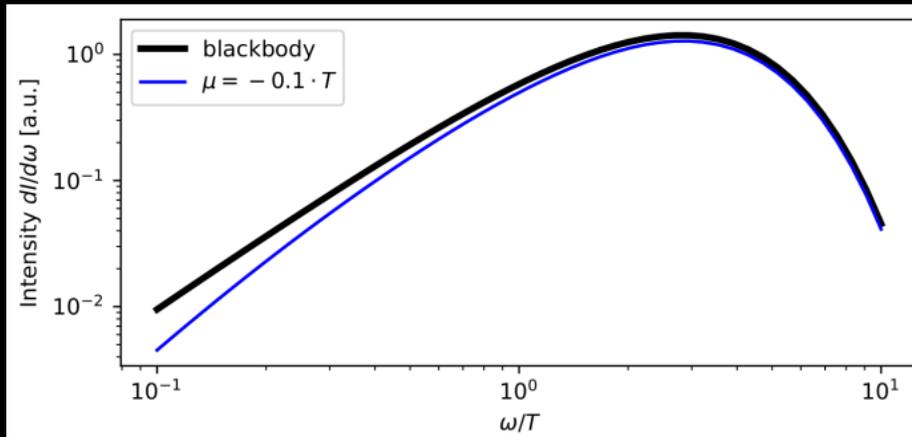
$T < 100\text{eV}$, No thermalization: Case by Case Study

Spectral Distortion: Any deviation of the CMB Blackbody Spectrum. μ – distortion.

μ -Distortion created if energy is injected within this period

$$\frac{dI}{d\omega} \propto \omega^3 \frac{1}{\exp((\omega - \mu)/T) - 1}$$

$T < 1\text{keV}$, No more Brehmstrahlung, Double Compton Scattering.



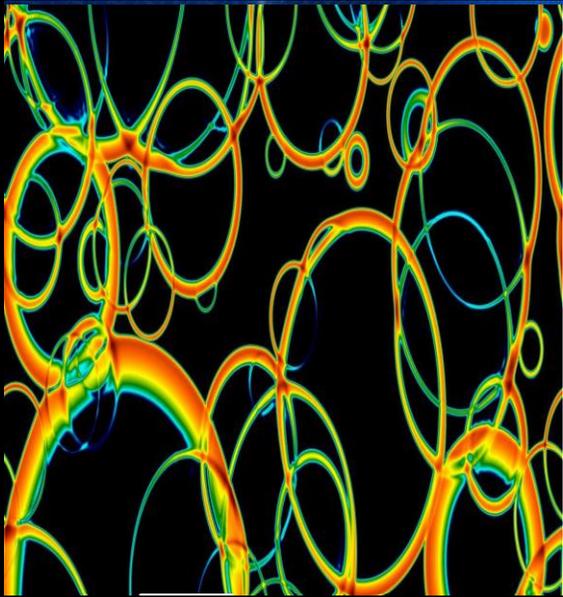
• Photon Number Conserved: Chemical Potential

• $\mu \sim \frac{\rho_{in}}{\rho_{\gamma}} \leq 10^{-4}$ COBE/FIRAS

• $\mu \sim \frac{\rho_{in}}{\rho_{\gamma}} \leq 10^{-8}$ Future PIXIE Voyage

Motivation & Main Idea.

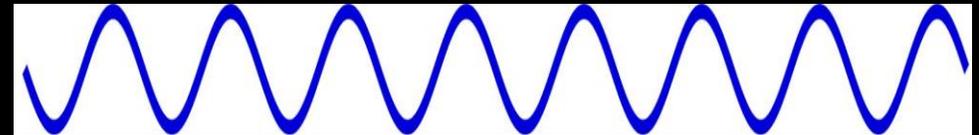
Turbulent Dark Sector Purely Gravitationally Coupled to the SM Plasma.



**FOPTs, Meta-Stable
Topological
Defects: (Domain-
Walls, String)**

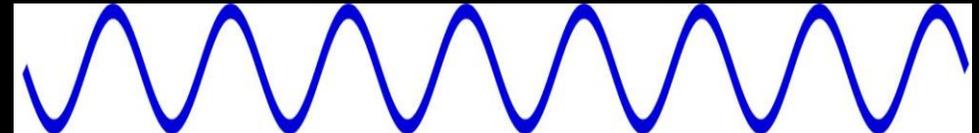
GW's cause deformation of Plasma
which cause it to heat up.

$$\mu \sim \frac{\rho_{\text{in}}}{\rho_{\gamma}} \simeq 10^{-5} \Omega_{GW}$$

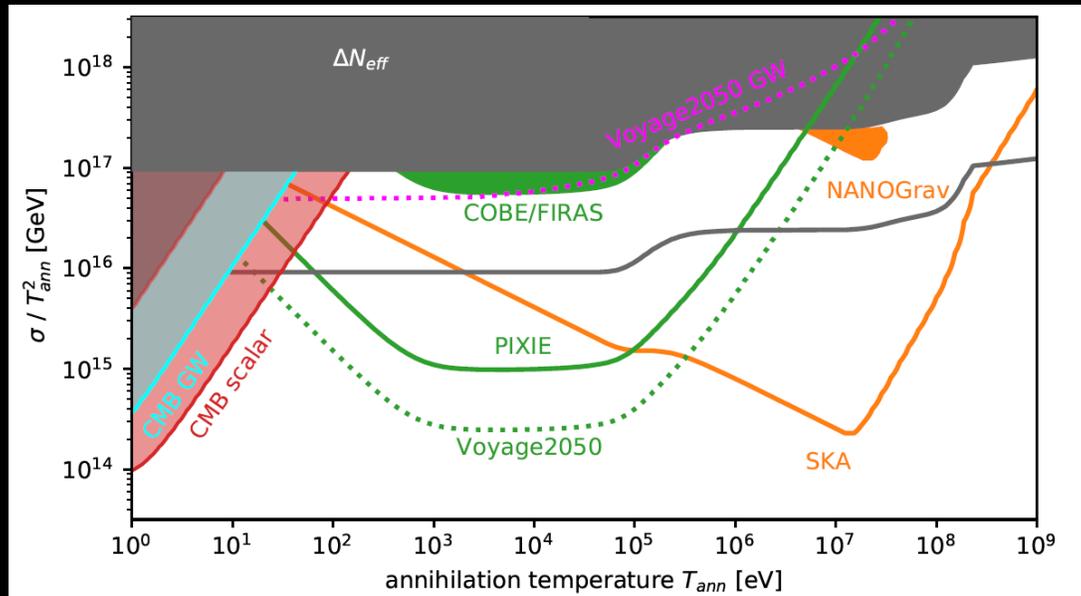


Induced Acoustic Waves in
Baryon-Photon Fluid due to
Gravitational interaction between

DS and SM plasma $\mu \sim \frac{\rho_{\text{in}}}{\rho_{\gamma}} = \frac{\rho_{\text{ac}}}{\rho_{\gamma}}$



Results for some examples (Annihilating DWs, DS FOPT, Directly coupled FOPT)



Conclusion: Spectral Distortions is a powerful probe of gravitationally coupled sector, with a great deal of complementarity with GWs in the PTA Range.

