

Origin of the suppression in the power spectrum of primary gravitational waves at high frequencies

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Based on - Work with Alipriyo Hoory, Jérôme Martin, L. Sriramkumar

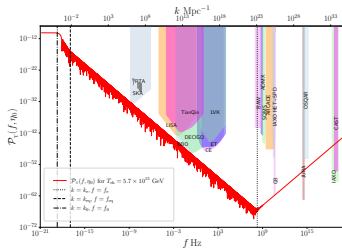
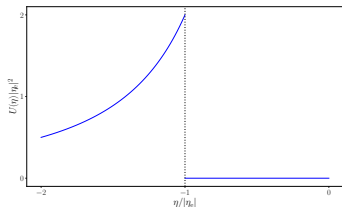
Rise of PS at small scales (small $\equiv$ sub-Hubble at all time)

$$\mathcal{P}_T(k, \eta) = 4k^3 |\mu_k(\eta)/a|^2 / (\pi^2 M_{\text{Pl}}^2)$$

where $h_k \equiv \sqrt{2} \mu_k / (M_{\text{Pl}} a)$ and $\mu_k'' + (k^2 - a''/a) \mu_k = 0$

$$U(\eta) = \frac{a''}{a} = \begin{cases} \frac{2}{\eta^2}, & \text{for } \eta \leq \eta_e, \\ 0, & \text{for } \eta > \eta_e. \end{cases}$$

$$\mathcal{P}_T(k, \eta) \propto k^2 \text{ at } k \gg k_e$$

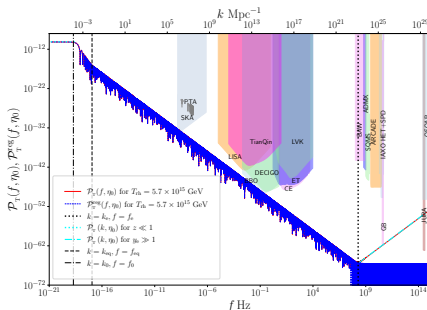


Regularized PS for instantaneous transition

Performing **adiabatic regularization**: $\mathcal{P}_T^{\text{reg}} \equiv \mathcal{P}_T - \mathcal{P}_T^{\text{ad}}$, where

$$\mathcal{P}_T^{\text{ad}}(k, \eta) = \frac{2k^2}{\pi^2 M_{\text{Pl}}^2 a^2} \left(1 + \frac{a''}{2k^2 a} \right)$$

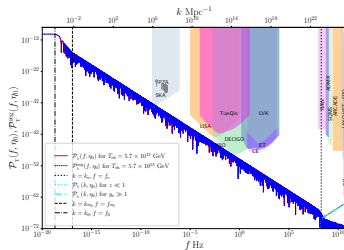
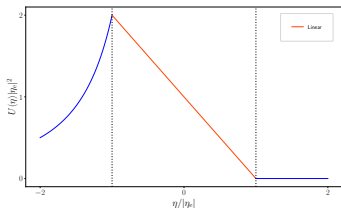
$$\mathcal{P}_T^{\text{reg}}(k, \eta) \propto \cos(2k/k_0) \text{ at } k \gg k_e$$



Regularized PS for a smoother transition

$$U(\eta) = \frac{a''}{a} = \begin{cases} \frac{2}{\eta_e^2}, & \text{for } \eta \leq \eta_e, \\ -\frac{2}{\eta_e^2 \Delta \eta} [\eta - (\eta_e + \Delta \eta)], & \text{for } \eta_e \leq \eta \leq \eta_e + \Delta \eta, \\ 0, & \text{for } \eta \geq \eta_e + \Delta \eta. \end{cases}$$

$$\mathcal{P}_T^{\text{reg}}(k, \eta) \propto k^{-1} \cos(2k/k_0) \text{ at } k \gg k_e$$



- ▶ Regularization is required to truncate the k^2 rise of PS of PGWs at small scales: **adiabatic regularization**.
- ▶ For a scenario with instantaneous transition, regularized PS is oscillatory with fixed amplitude at small scales.
- ▶ **Smoothing** the effective potential $U(\eta)$ is **necessary** to get a decreasing PS at small scales.