

Spectator Composes Gravitational Canon

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[YB, Keisuke Harigaya, arXiv: 2601.04307]

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Phase Transition: Pre-inflationary or Post-inflationary?

Pre-inflationary	GUT, Affleck-Dine, ...
Post-inflationary	Electroweak, QCD, ...
Either	Peccei-Quinn
?	?

During Inflation?

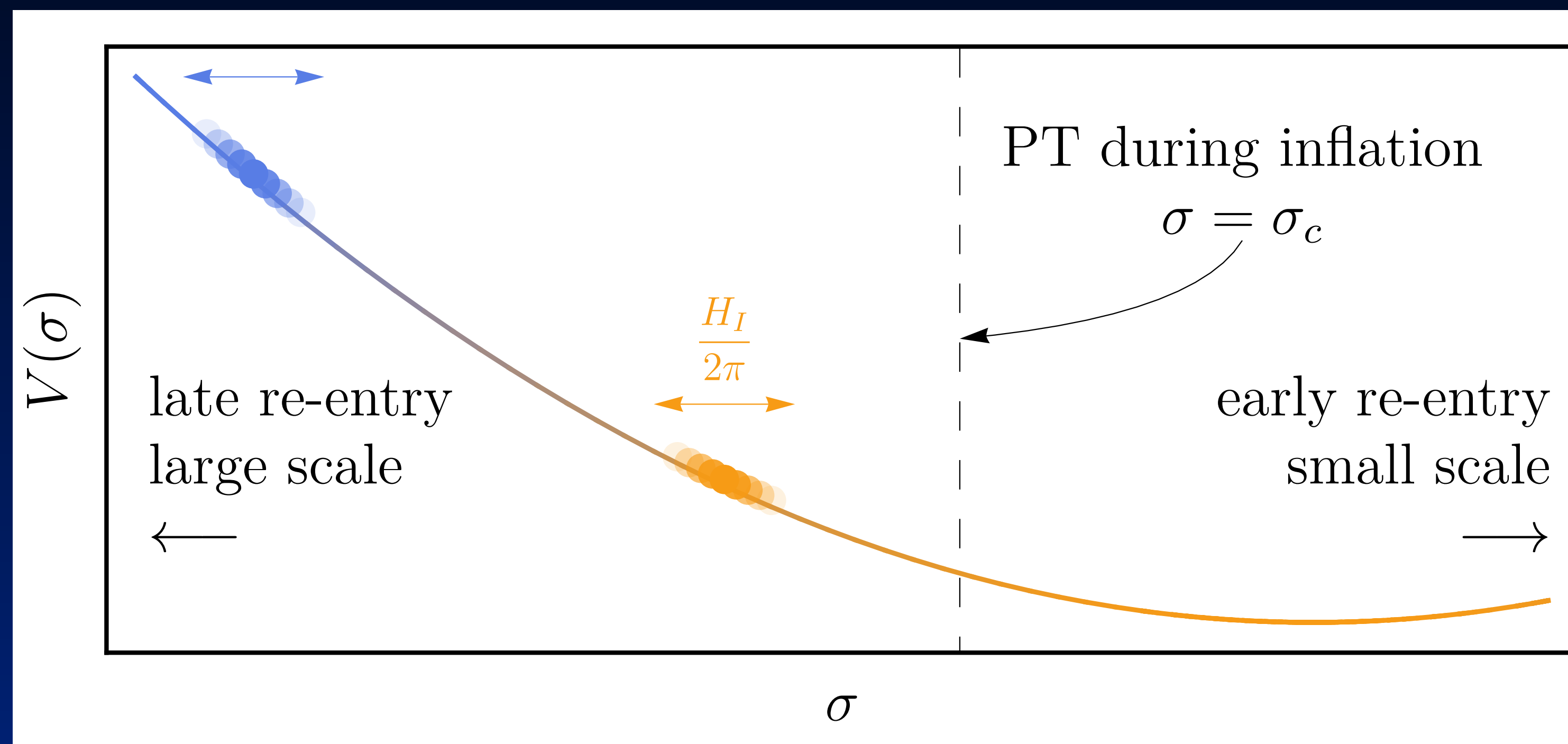
- A spectator σ with $m_\sigma \lesssim H_I$

- Undergoes slow roll

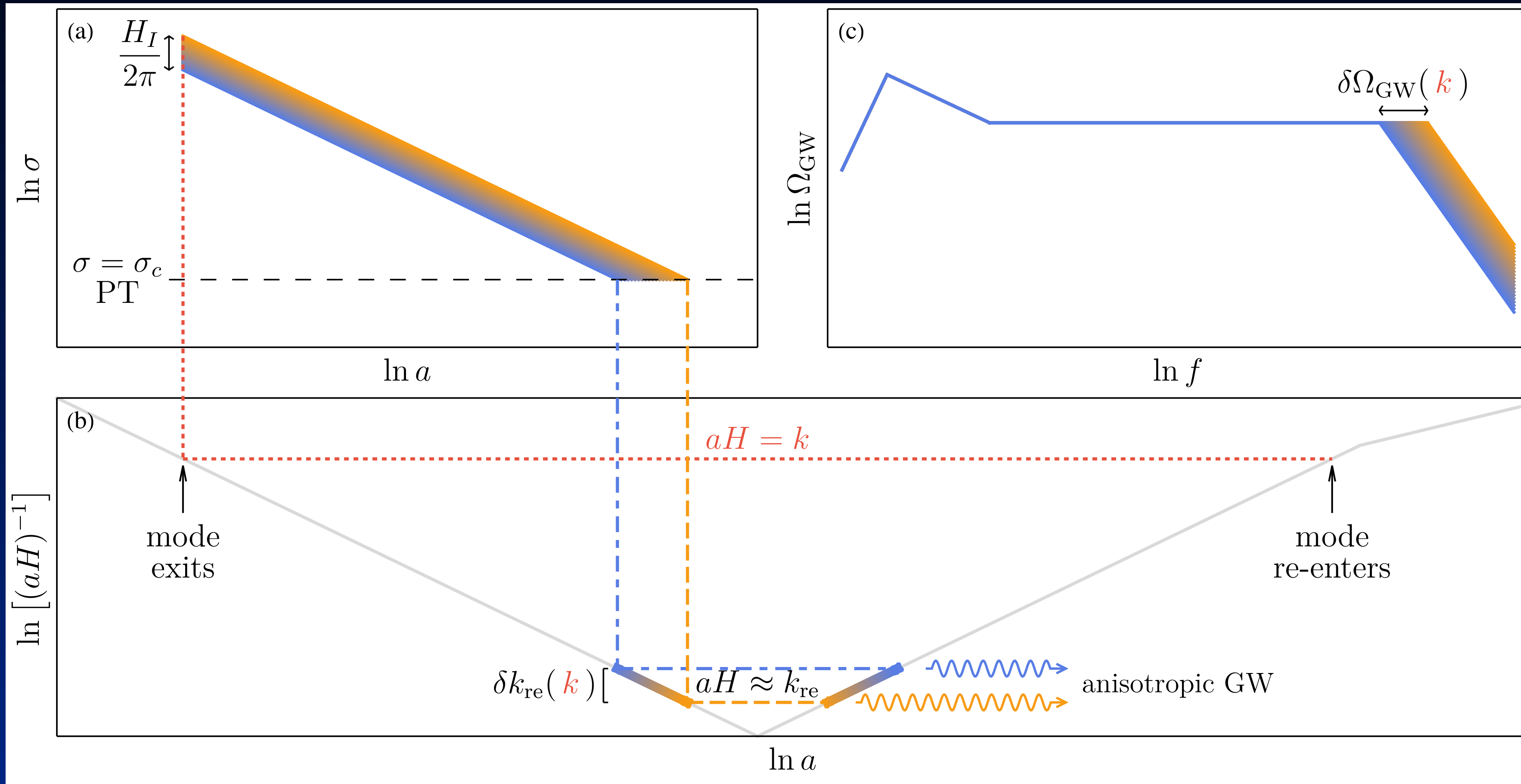
- Also have $\delta\sigma \sim \frac{H_I}{2\pi}$

- Can it trigger a phase transition as it rolls?

$$V(\chi) \supset (\sigma^2 - \sigma_c^2)\chi^2$$



$$\delta\sigma \rightarrow \delta a_{\text{PT}} \rightarrow \delta k_{\text{re}} \rightarrow \delta\Omega_{\text{GW}}(\ell, f)$$

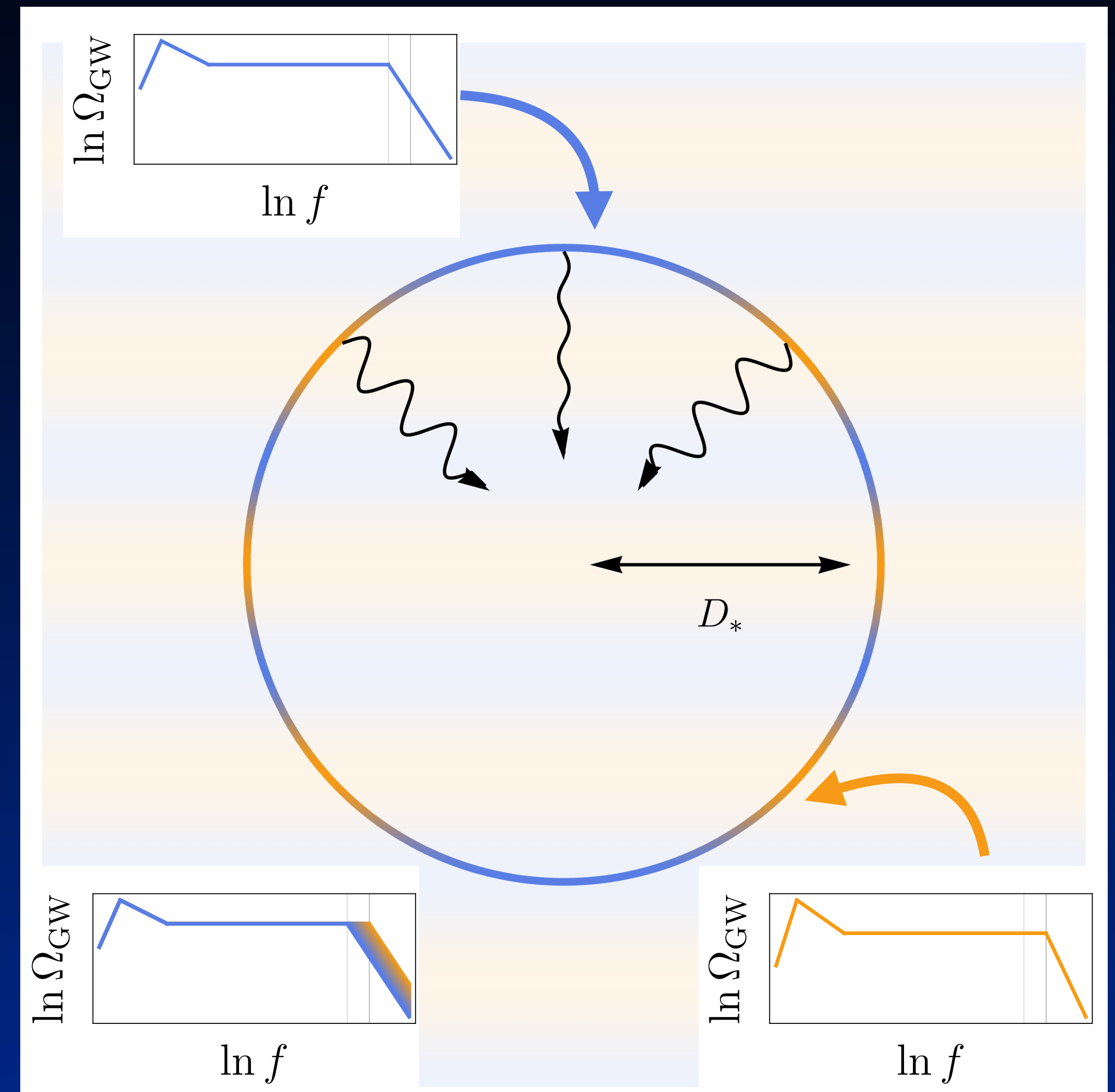


Gravitational Wave Anisotropy

$$\ell \approx D_* k,$$

- D_* : comoving distance to last-scattering surface
- k : wavevector of some mode

$$\Omega_{\text{GW}}(k_{\text{re}}, f) \rightarrow \Omega_{\text{GW}}\left(\frac{\delta\sigma}{\sigma}(\ell), f\right).$$

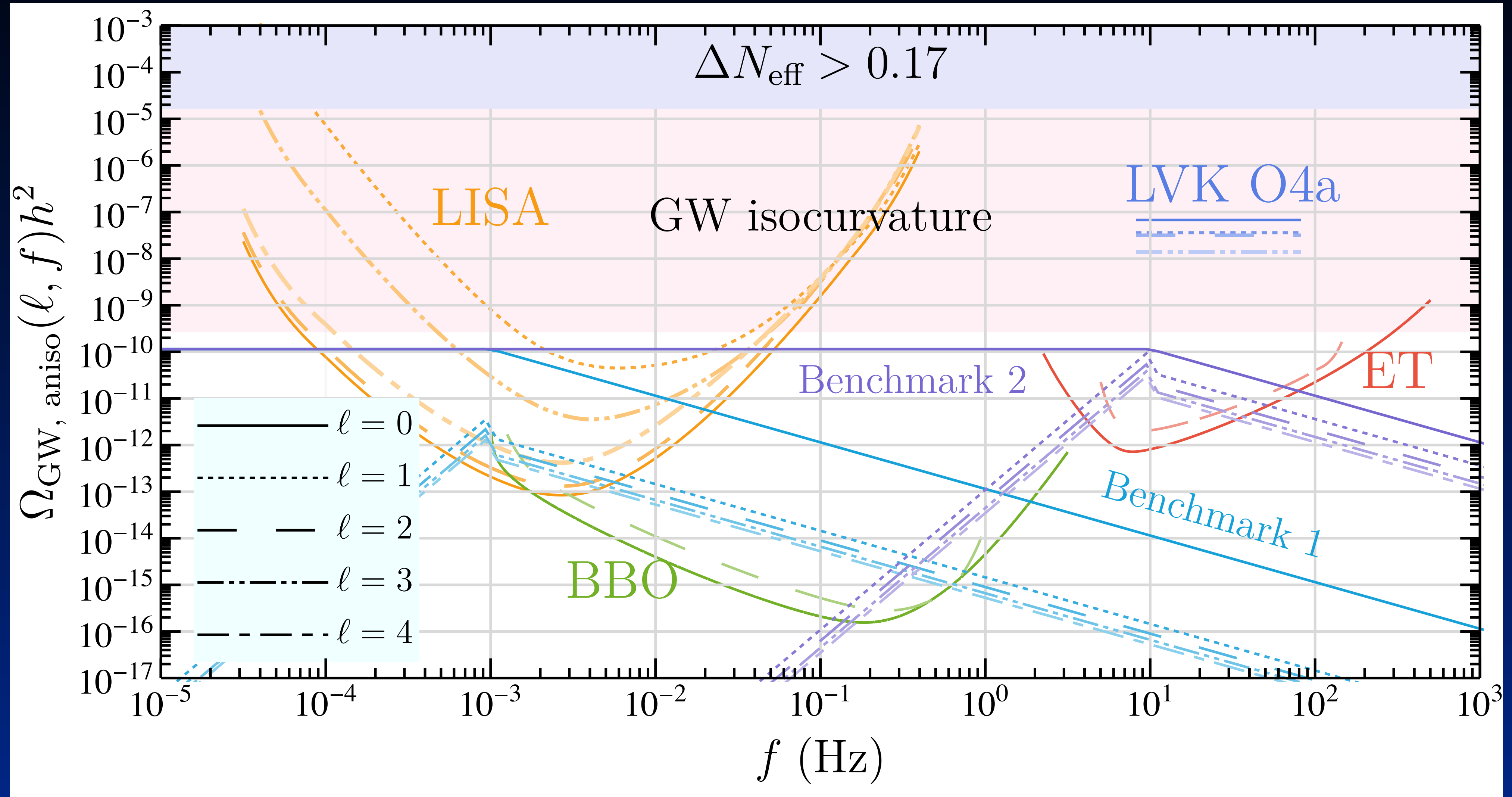


Benchmark Realization

GW Anisotropy from Cosmic Strings

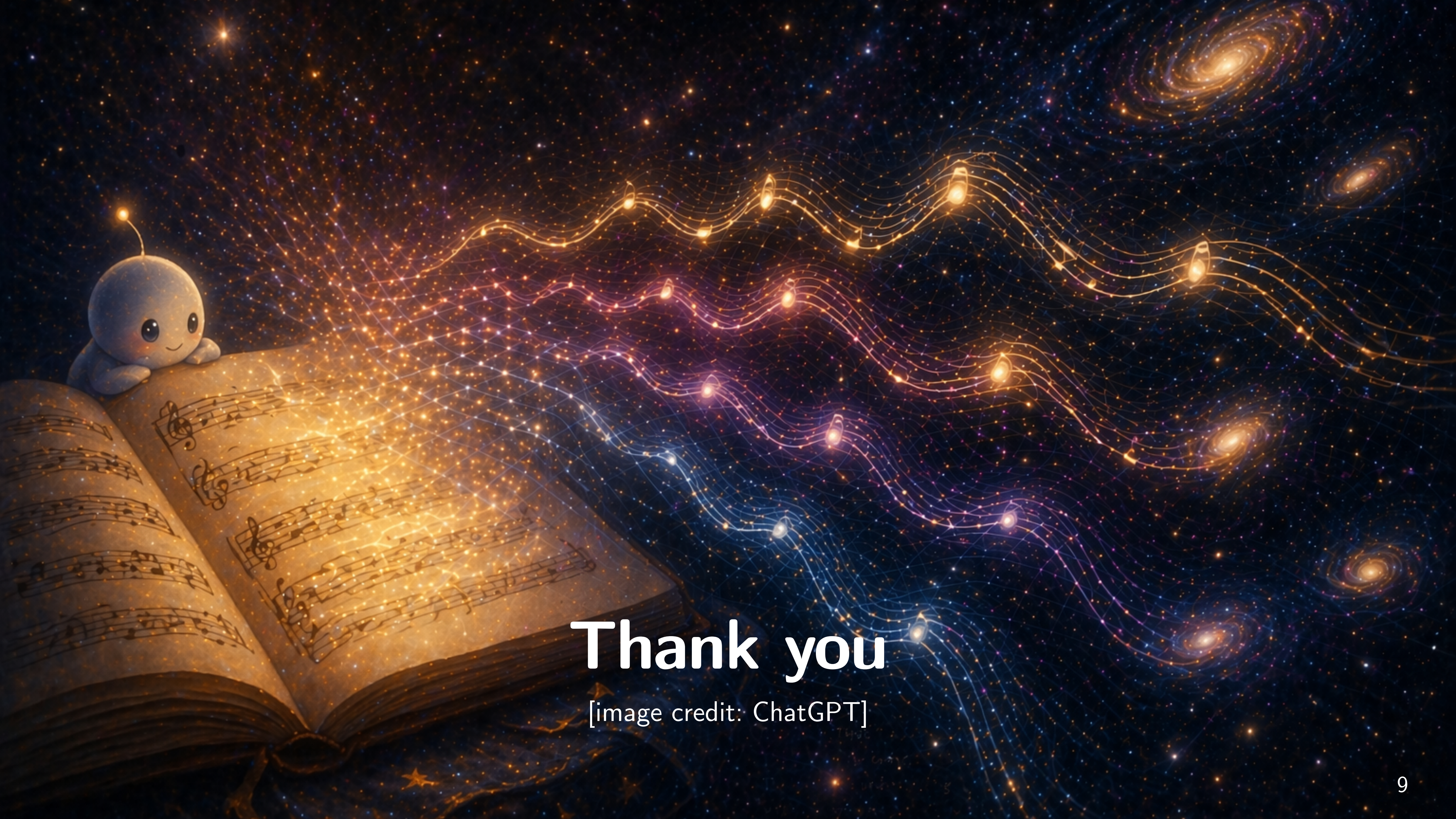
- $V \supset (\lambda_{\sigma\chi}^2 \sigma^2 - m_\chi^2) |\chi|^2 + \frac{\lambda_\chi^2}{4} |\chi|^4 \quad \text{U(1)}_\chi \rightarrow \emptyset$
- $\Omega_{\text{GW}}(f) \supset \frac{\sqrt{\mu}}{M_{\text{Pl}}} \begin{cases} \left(\frac{f}{f_{\text{re}}}\right)^3, & f < f_{\text{re}}, \\ \left(\frac{f}{f_{\text{re}}}\right)^{-1}, & f \geq f_{\text{re}}. \end{cases}$
- Gauge cosmic strings mostly decay into GW, so most $\delta\sigma$ is encoded in $\delta\Omega_{\text{GW}}$.
- We can easily embed this in an MSSM extension, and the Higgs can be σ .

Experimental Signature



How can I play with this framework?

- Change your favorite phase transition
- Change your favorite GW production mechanism
- Change your favorite quantity that (probably) depends on σ .
- And have fun!



Thank you

[image credit: ChatGPT]