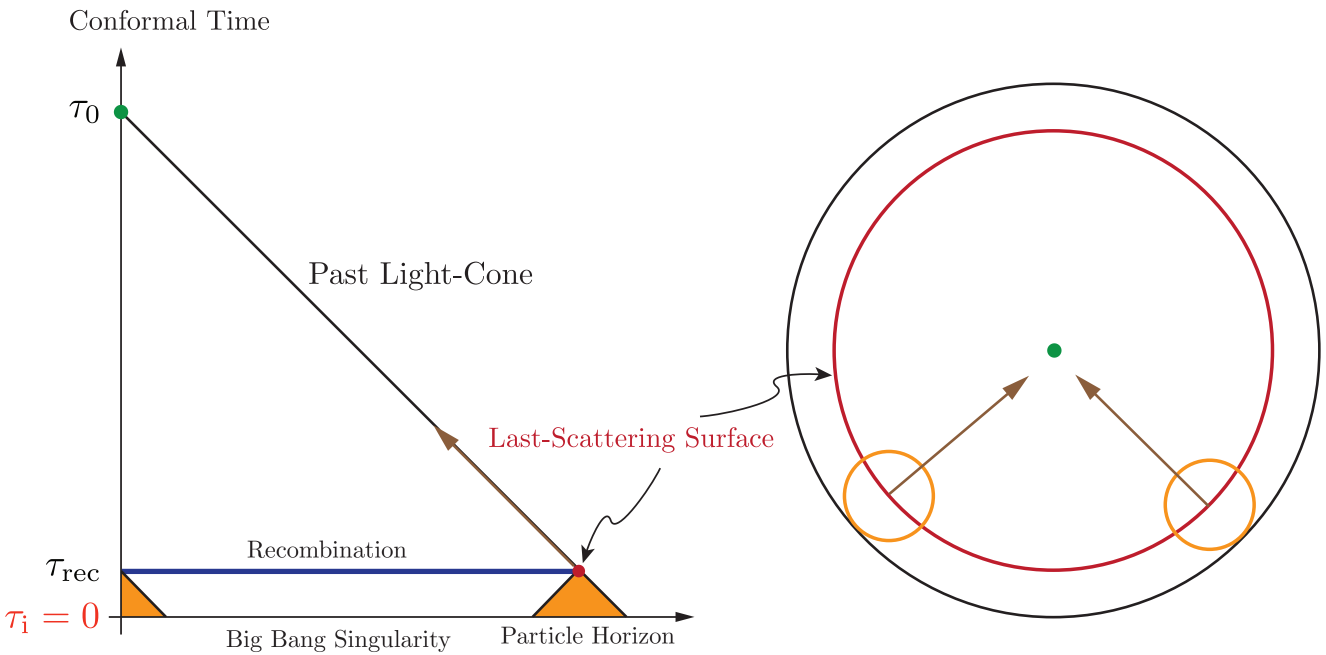
Probing cosmic inflation with LiteBIRD

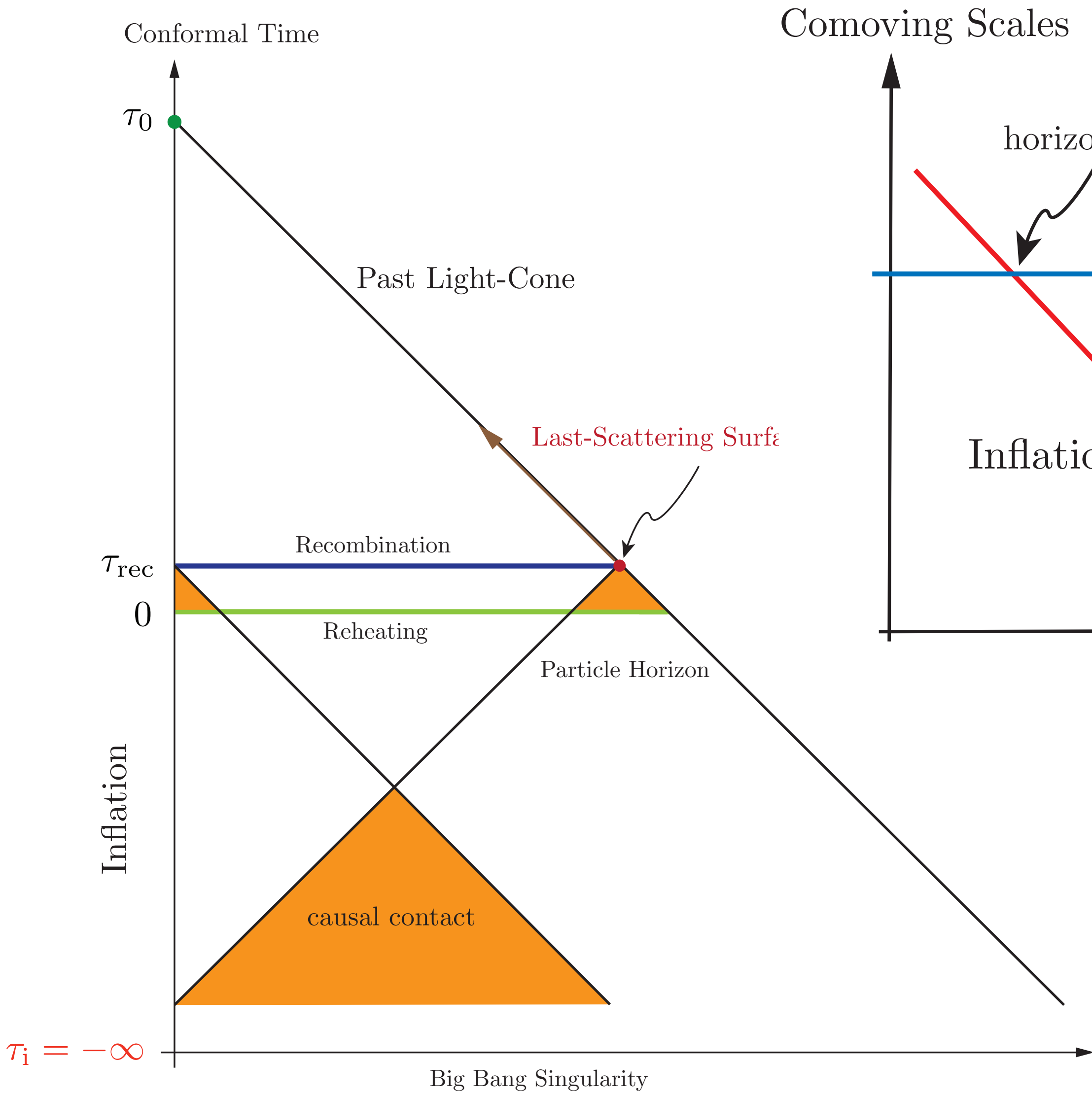
Clément Leloup for the LiteBIRD collaboration

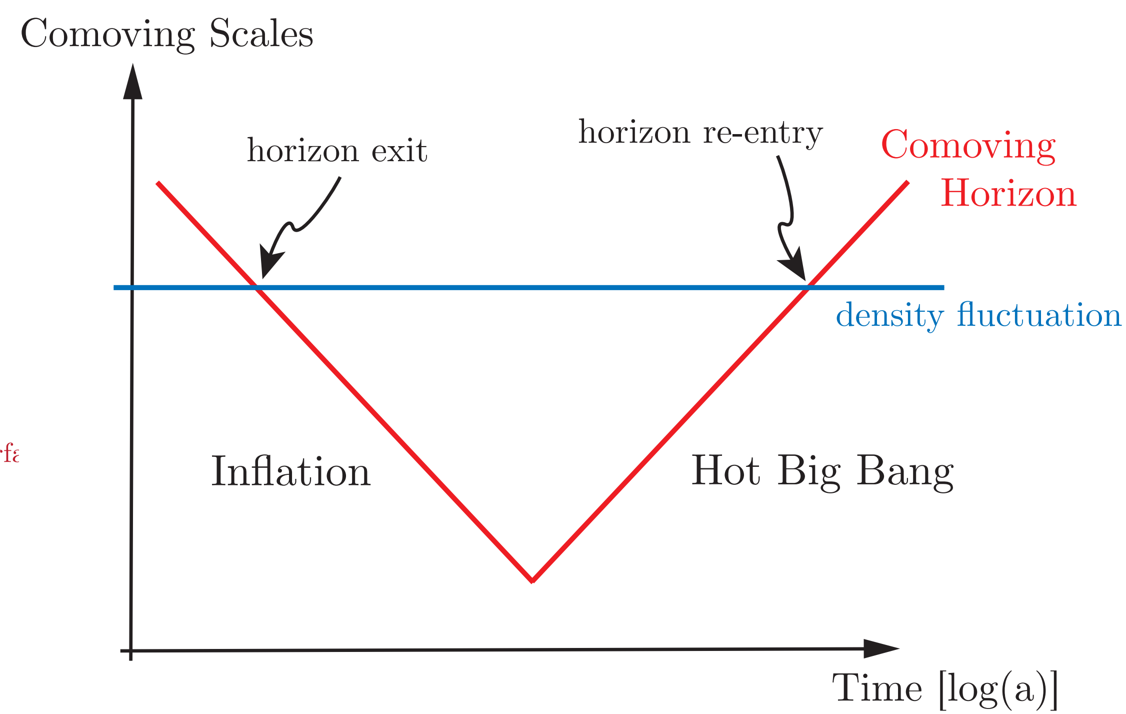
Why inflation ?



Credits: D. Baumann

Why inflation ?





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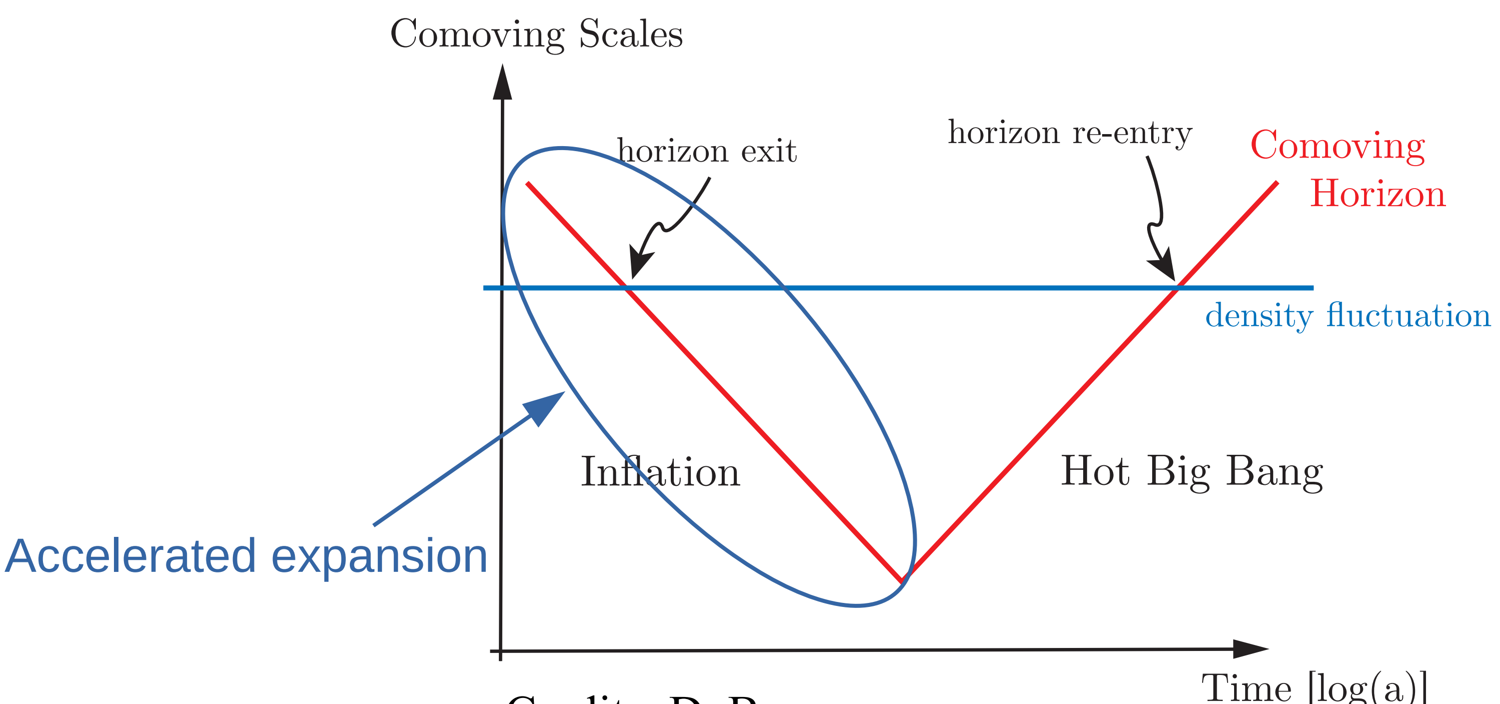
Why inflation ?



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- Shrinking comoving Hubble radius means:

$$0 > \frac{d}{dt}(aH)^{-1} = -\frac{\ddot{a}}{(aH)^2}$$

Why inflation ?

- This phase of accelerated expansion also solves the apparent spatial flatness while this is an unstable state:

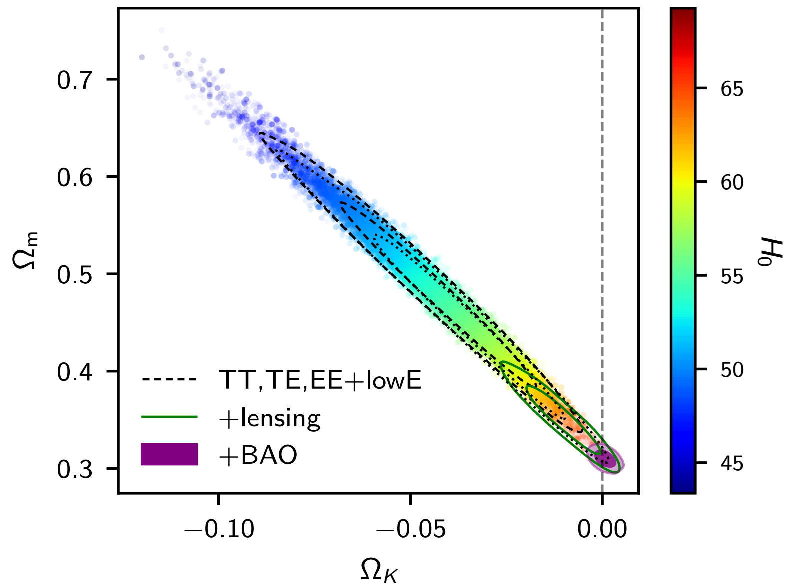
$$1-\Omega\left(a\right)=-\frac{K}{\left(aH\right)^{2}}\equiv\Omega_{K}\left(a\right)$$

- During inflation:

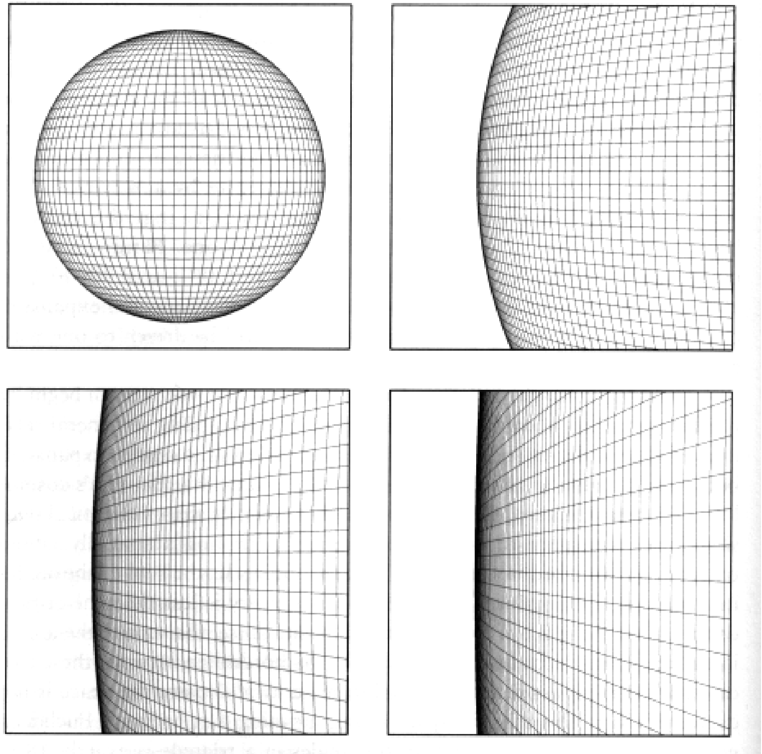
$$1-\Omega\left(a\right)\rightarrow 0$$

- Today:

$$\Omega_{K}=0.0007\pm0.0019$$



Planck 2018



How inflation ?

- Accelerated expansion requires, from Friedmann equation:

$$\frac{\ddot{a}}{a} = -\frac{1}{6}(\rho + 3p) \Rightarrow p < -\frac{1}{3}\rho$$

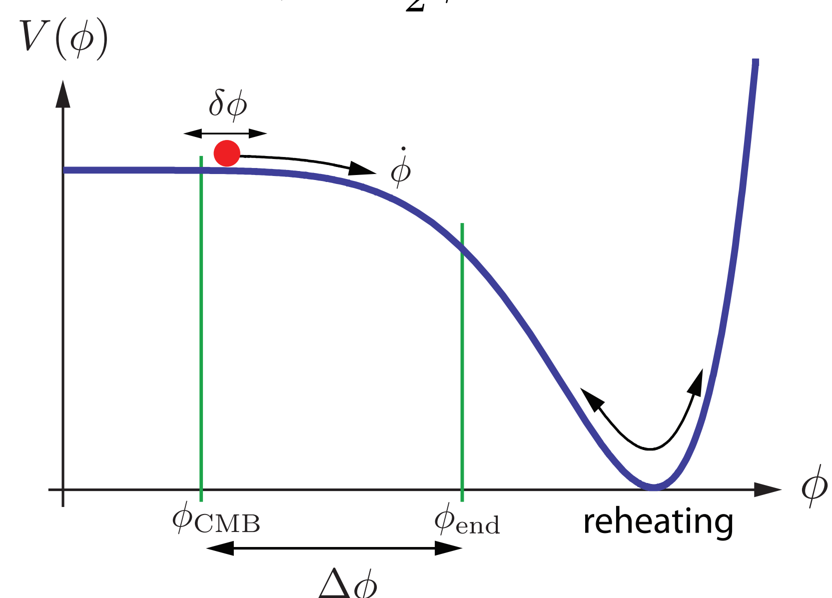
- Easily implemented by introducing a scalar degree of freedom:

$$\mathcal{L}_\phi = \frac{1}{2} g^{\mu\nu}\partial_\mu\phi\,\partial_\nu\phi - V(\phi) \qquad \Rightarrow \qquad w_\phi = \frac{p_\phi}{\rho_\phi} = \frac{\frac{1}{2}\dot{\phi}^2 - V}{\frac{1}{2}\dot{\phi}^2 + V}$$

- We introduce slow-roll parameters to quantify the flatness of the potential

$$\epsilon_V \equiv \frac{M_P^2}{2}\left(\frac{V_{,\phi}}{V}\right)^2 \ll 1$$

$$\eta_V \equiv M_P^2 \frac{V_{,\phi\phi}}{V} \ll 1$$



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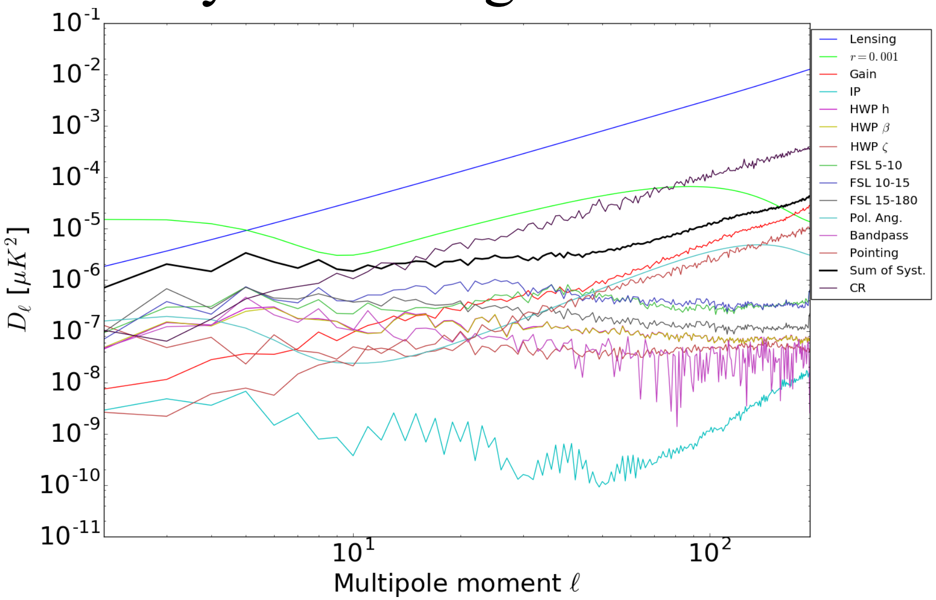
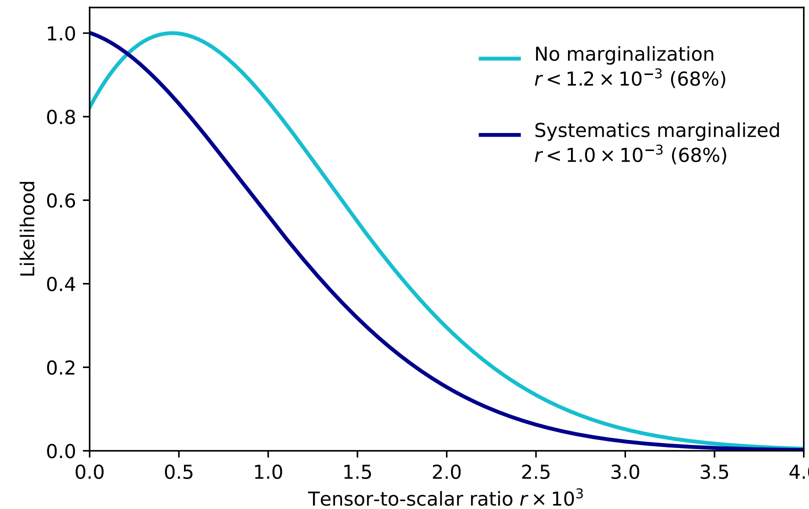
LiteBIRD contribution

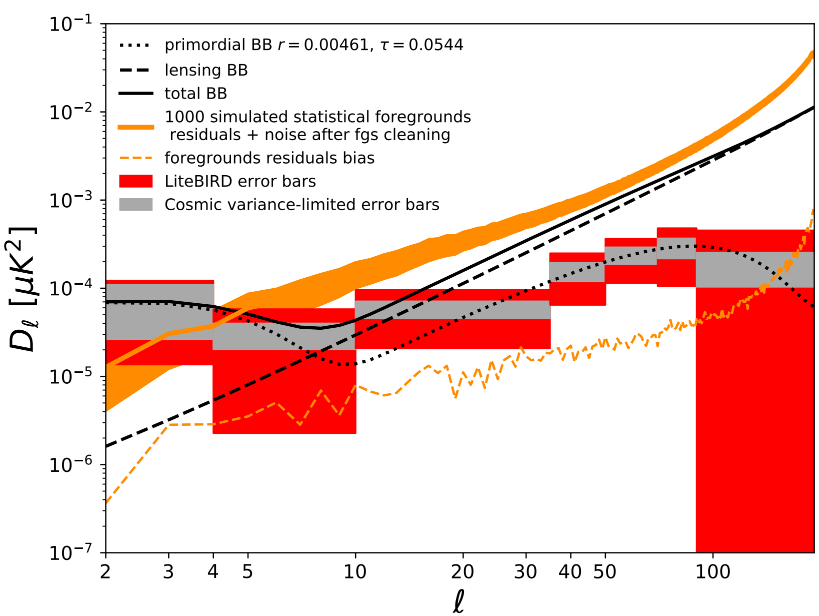
- By measuring the CMB B modes, LiteBIRD can constrain inflation

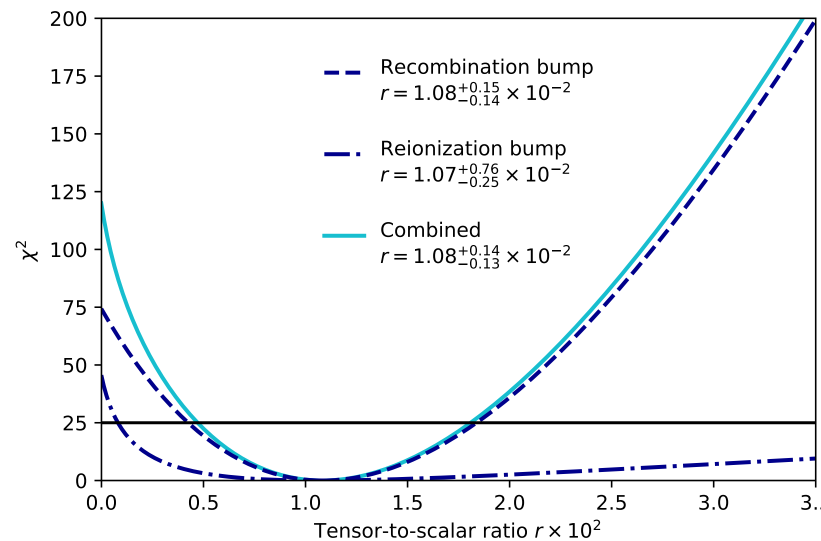


$\Longrightarrow$



$r = 0$

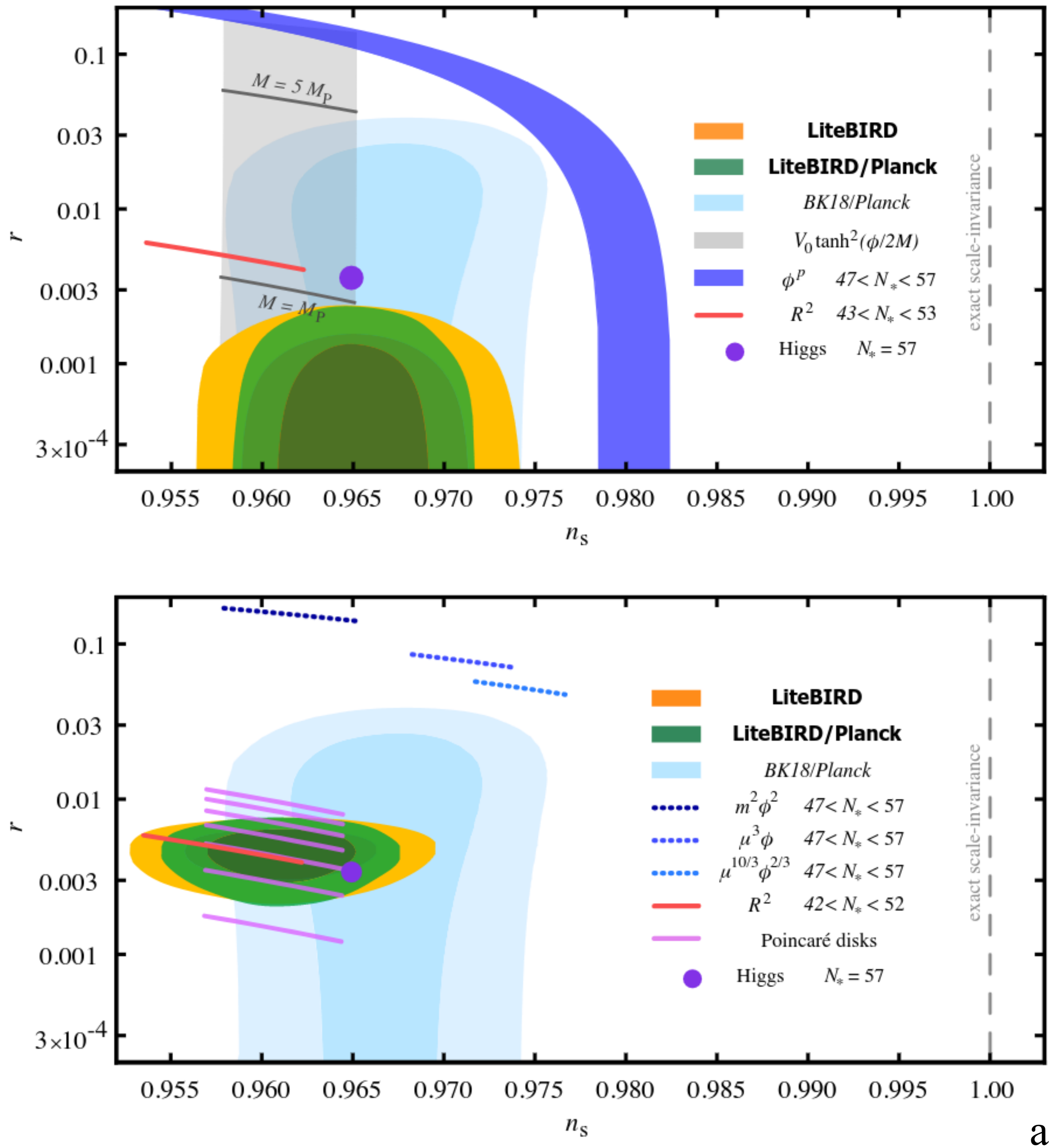




arXiv:2202.02773

$r = 10^{-2}$

LiteBIRD contribution



- From constraints on r and under slow-roll assumptions, we can infer:
  - Energy scale of inflation

$$V^{1/4} = 1.04 \times 10^{16}\mathrm{GeV}\left(\frac{r}{0.01}\right)^{1/4}$$

  - Distance traveled by the inflaton

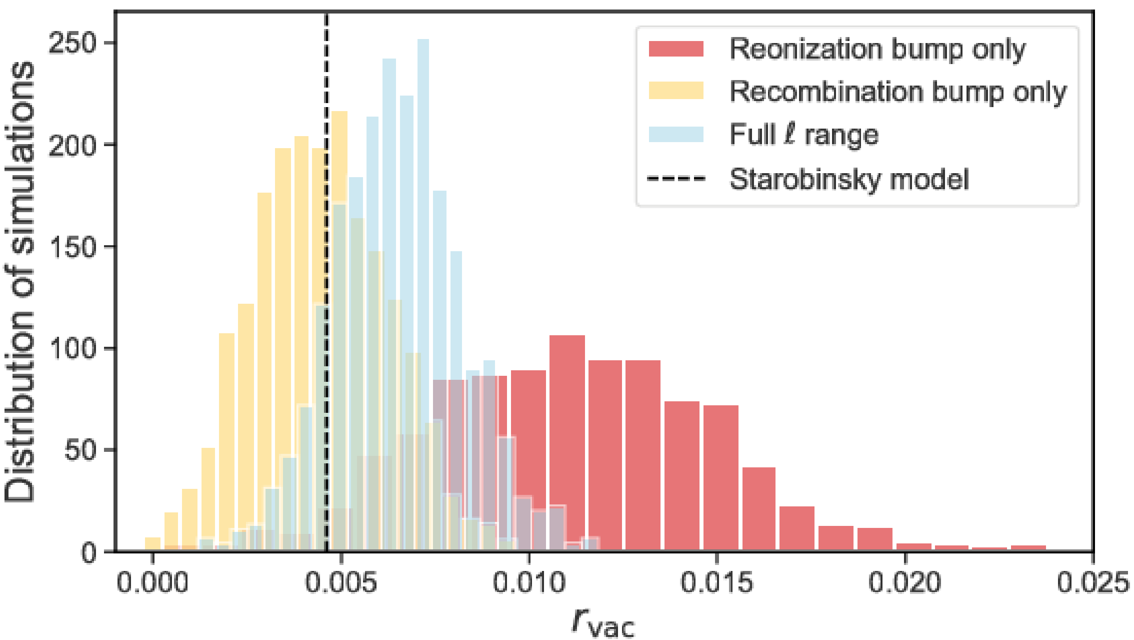
$$\frac{\Delta\phi}{M_P} \gtrsim \left(\frac{r}{8}\right)^{1/2} N_*$$

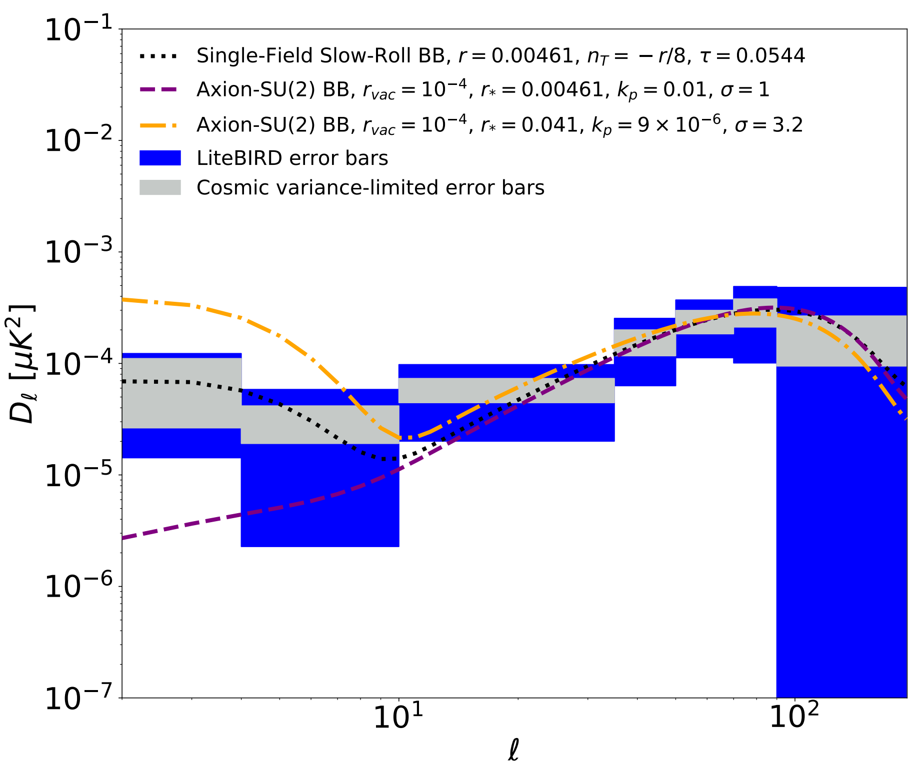
arXiv:2202.02773

LiteBIRD contribution

- Beyond single-field slow-roll scenario:
  example of the spectator axion-SU(2) gauge field inflation

$$\mathcal{L} = \mathcal{L}_\phi - \frac{1}{2} g^{\mu\nu} \partial_\mu \chi \partial_\nu \chi - V(\chi) - \frac{1}{4} F^a_{\mu\nu} F^{a\mu\nu} + \frac{\lambda}{4f} \chi F^a_{\mu\nu} \tilde{F}^{a\mu\nu}$$





Campeti et al. (2023)

LiteBIRD contribution

- Other potential contributions from LiteBIRD:
  - Investigate the slow-roll consistency relation

$$r = -8n_t$$

  - Non-gaussianities of CMB polarization
  - Constraints on inflation from E-modes
  - Primordial magnetic fields produced during inflation