CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE

Preheating
The String Axiverse

Non-perturbative production of heavy DM

Margherita Putti

INVISIBLES 2024

Work with
N. Righi, J. Leedom, A. Westphal
arXiv:2407.xxxx

Axion - saxion

- $\mathcal{N} = 1$ type IIB compactification on CY_3
- At least 1 Kähler modulus τ + axion θ
  $\rightarrow$ complexified field $T = \tau + i\theta$

saxion

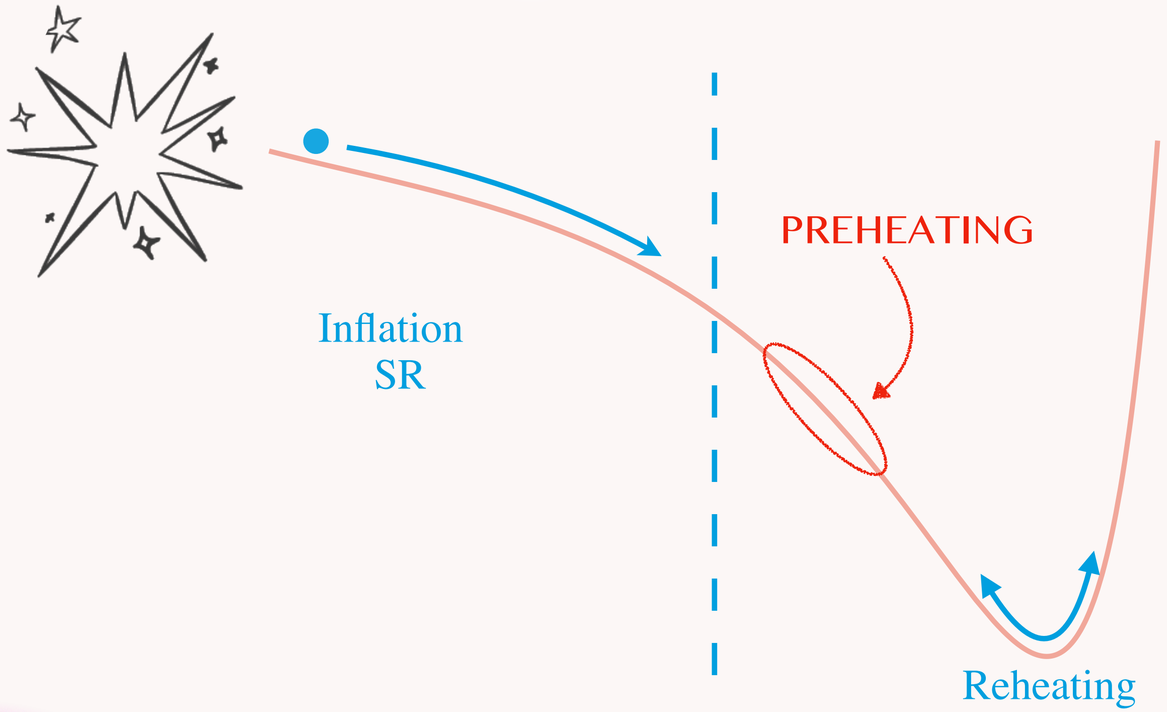
axion

$$\begin{cases} \mathscr{L}_{kin} \supset \dfrac{1}{\tau^2}(\partial\tau)^2 + \dfrac{1}{\tau^2}(\partial\theta)^2 \\ V \supset \Lambda\, e^{-a\tau}\left(1 + \cos(a\theta)\right) \end{cases}$$

$\Rightarrow$ Very simple, but generic!

String Inflation saxion $\leftrightarrow$ inflaton

Preheating



$$\phi \simeq \langle\phi\rangle + \Delta\phi\cos(mt)$$

$$\chi(t,\vec{x}) = \langle\chi\rangle + \delta\chi_k(t,\vec{x})$$

$$\ddot{\chi}_k + \left(A_k - 2q\cos(mt)\right)\chi_k = 0$$

$$\chi(t,\vec{x}) \propto e^{\mu_k t}$$

Mathieu equation

$$\tau \simeq \langle\tau\rangle + \Delta\tau\cos(mt)$$

$$\ddot{\chi}_k - 2\beta\frac{\Delta\tau}{\langle\tau\rangle}\dot{\chi}_k\sin(m_\tau t) + \left(k^2 + \Lambda a e^{-a\langle\tau\rangle}\left(\langle\tau\rangle + \Delta\tau\cos(m_\tau t)\right)e^{-a\Delta\tau\cos(m_\tau t)}\right)\chi_k = 0$$

resonance parameter q

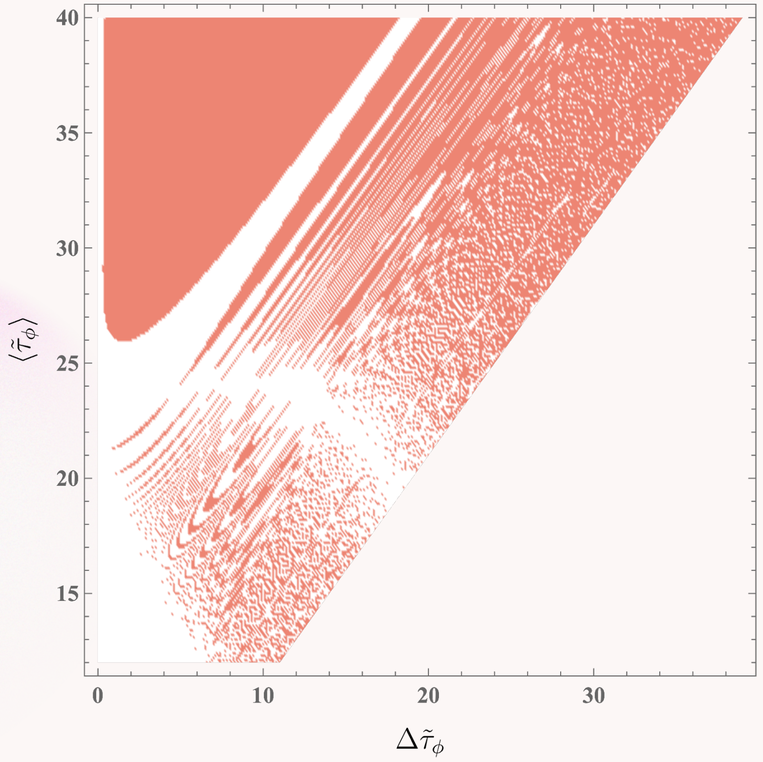
$$q = 4a\Delta\tau\frac{m_\theta^2}{m_\tau^2}\left(1 - \frac{1}{a\langle\tau\rangle}\right)$$

Stability charts

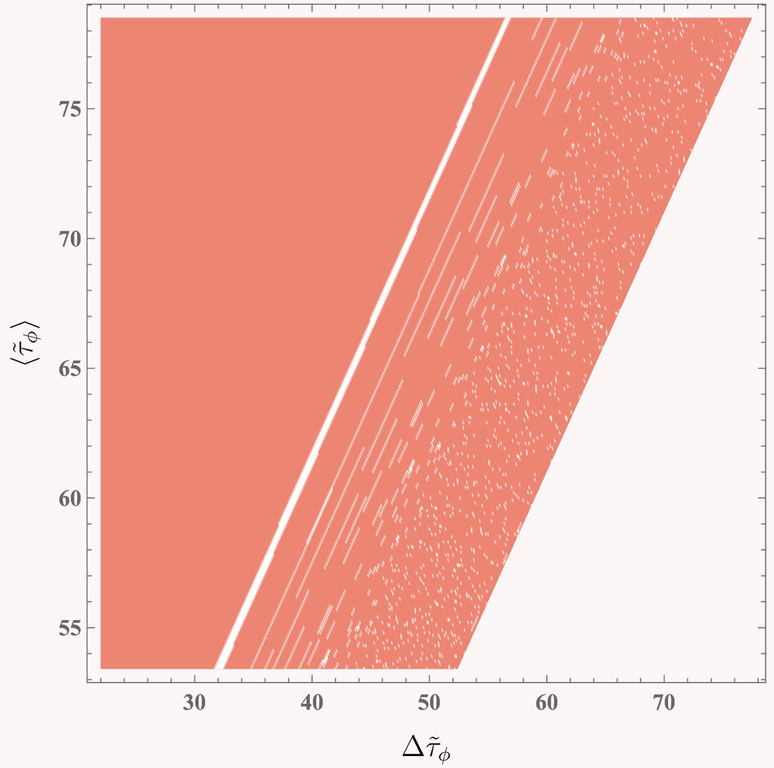
$$q = 4a\Delta\tau\frac{m_\theta^2}{m_\tau^2}\left(1 - \frac{1}{a\langle\tau\rangle}\right)$$

- Dark radiation: $m_a \leq 10^{-31} M_{pl} \rightarrow$ contribute to ΔN_{eff}
- Dark matter: $\Omega_\theta^0 = \dfrac{m_\theta n_\theta(a_0)}{\rho_c^0}$

$10^{-38} M_P \leq m_\theta \leq 10^{-31} M_P$



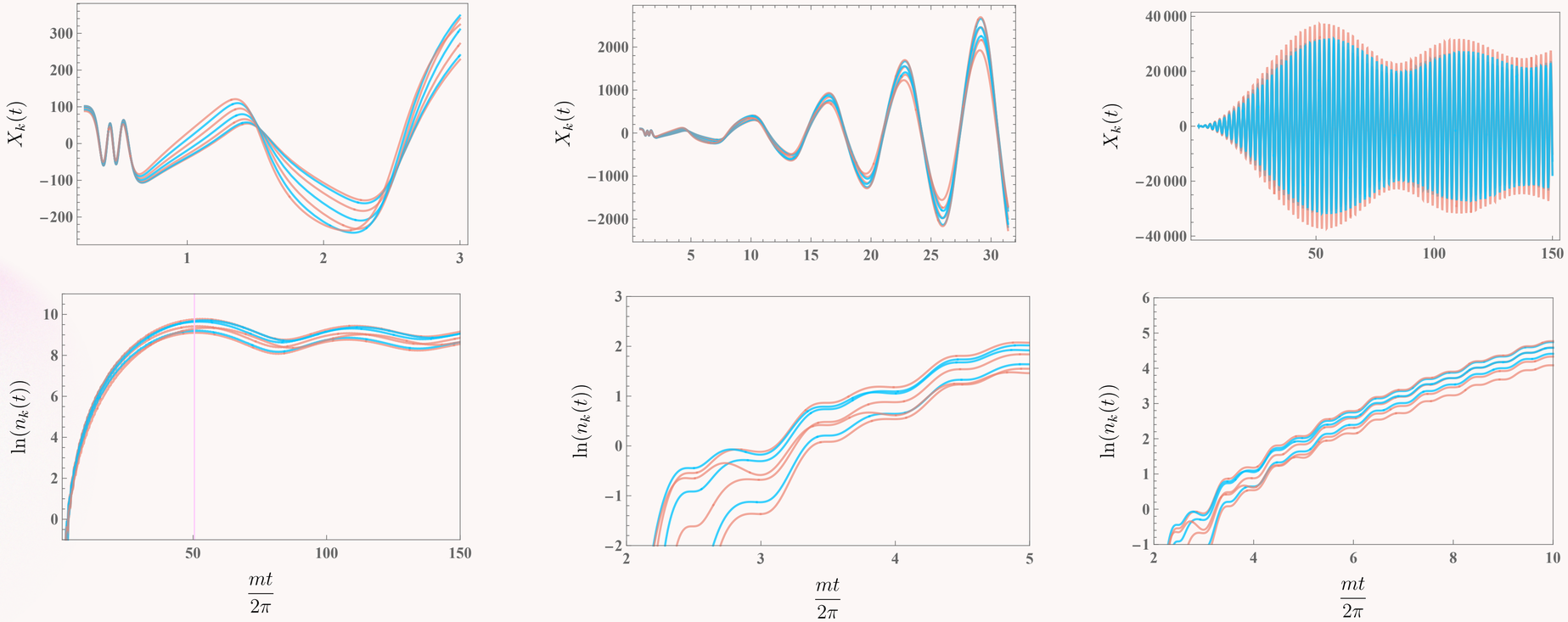
$10^{-11} M_P \leq m_\theta \leq 10^{-5} M_P$



Enhanced modes

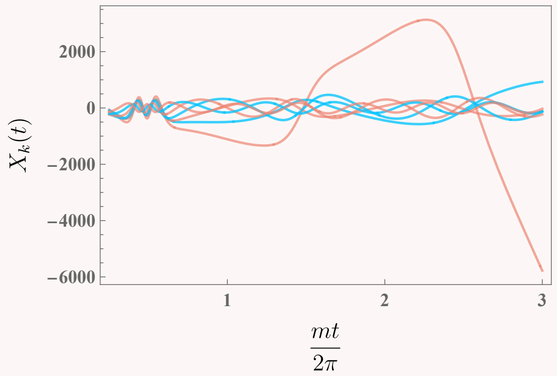
$$q = 4a\Delta\tau\frac{m_\theta^2}{m_\tau^2}\left(1-\frac{1}{a\langle\tau\rangle}\right)$$

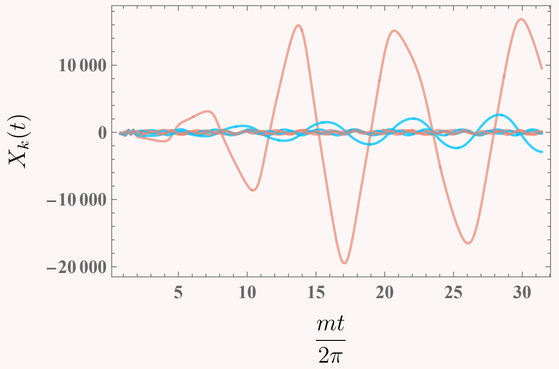
- Dark radiation: $m_a \leq 10^{-31}M_{pl} \rightarrow$ contribute to ΔN_{eff}
- Dark matter: $\Omega_\theta^0 = \dfrac{m_\theta n_\theta(a_0)}{\rho_c^0}$



Application: Fibre inflation

- Dark radiation: contribution to $\Delta N_{eff} \simeq 10^{-6}$
- Dark matter: $\Omega_\theta^0 h^2 \gg 0.12$





Come to my poster for more