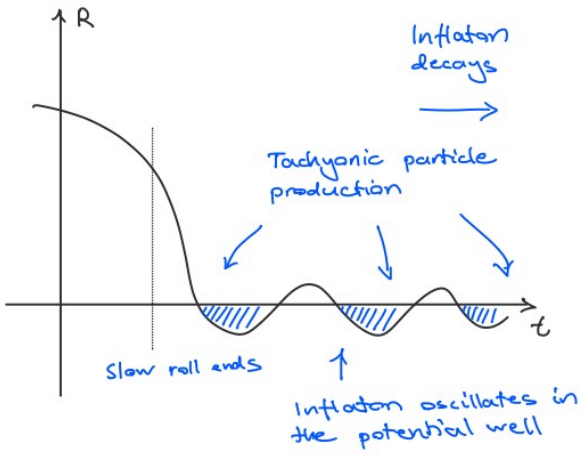
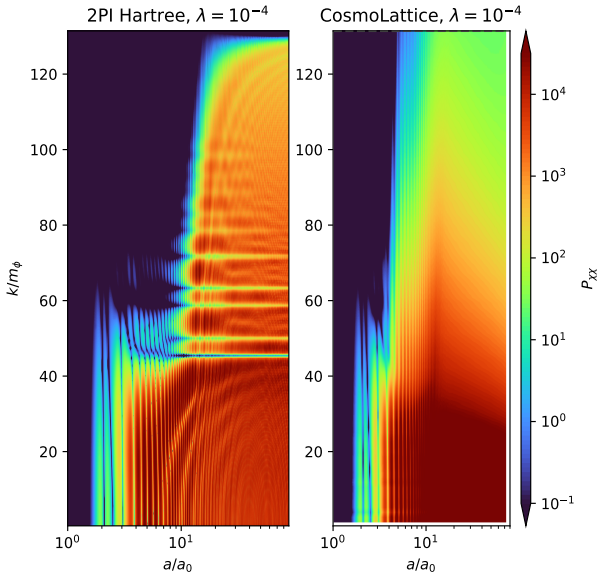
Tachyonic production of Dark Matter

Olli Väisänen
olli.j.r.vaisanen@jyu.fi

- **Out-of-equilibrium quantum effects** are important in the early universe.
- Case in point: Gravitational production of scalar dark matter during reheating.
- How to include quantum coherence effects into an essentially non-linear problem?





- **2PI-approach**: Formulate EOM for 2-point function as a generalized quantum Boltzmann equation.

$$\frac{1}{4}\partial_t^2\rho_{0\mathbf{k}} + \omega_{\mathbf{k}}^2\rho_{0\mathbf{k}} - \rho_2 = -\mathbf{Re}\langle C_0\rangle,$$

$$\partial_t\rho_{1\mathbf{k}} = \mathbf{Im}\langle C_0\rangle,$$

$$\partial_t\rho_{2\mathbf{k}} - \frac{1}{2}\partial_t\left[M_{\mathbf{eff}}^2\right]\rho_{0\mathbf{k}} = \mathbf{Re}\langle C_1\rangle.$$

$$\langle C_1\rangle = \lambda^2\int\frac{dk_1k_1^2}{2\omega_1}\int\frac{dk_2k_2^2}{2\omega_2}\frac{1}{2\omega_{\mathbf{k}}}F(k,k_1,k_2)$$
$$\times\left(\omega_1 f_{\mathbf{k}_1}^{<d}f_{\mathbf{k}_2}^{<s}(f_{\mathbf{k}_3}^{>s})^*f_{\mathbf{k}}^{>s} + \omega_2 f_{\mathbf{k}_1}^{<s}f_{\mathbf{k}_2}^{<d}(f_{\mathbf{k}_3}^{>s})^*f_{\mathbf{k}}^{>s}\right.$$
$$\left. - \omega_3 f_{\mathbf{k}_1}^{<s}f_{\mathbf{k}_2}^{<s}(f_{\mathbf{k}_3}^{>d})^*f_{\mathbf{k}}^{>s} + \omega_{\mathbf{k}} f_{\mathbf{k}_1}^{<s}f_{\mathbf{k}_2}^{<s}(f_{\mathbf{k}_3}^{>s})^*f_{\mathbf{k}}^{>d}\right)$$
$$-(>\leftrightarrow<),$$

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ