Higgs-Delayed Reheating

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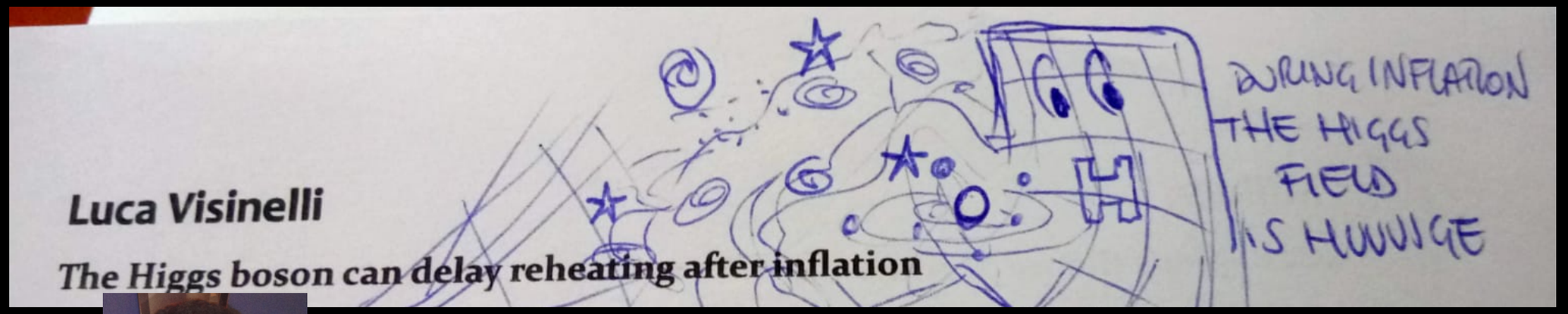
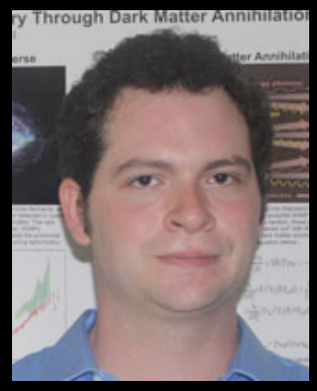


Freese, Sfakianakis, Stengel, **LV**,
JCAP **1805**, 067 (2018) 1712.03791



Inflation: early accelerated expansion of the Universe

Inflation explains why the Universe is homogeneous, flat, with no topological defects

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$$H^2 = \frac{8\pi G}{3}\rho \qquad \text{Friedmann}$$

$$\dot{\rho} + 3H(p+\rho) = 0 \qquad \text{Energy conservation}$$

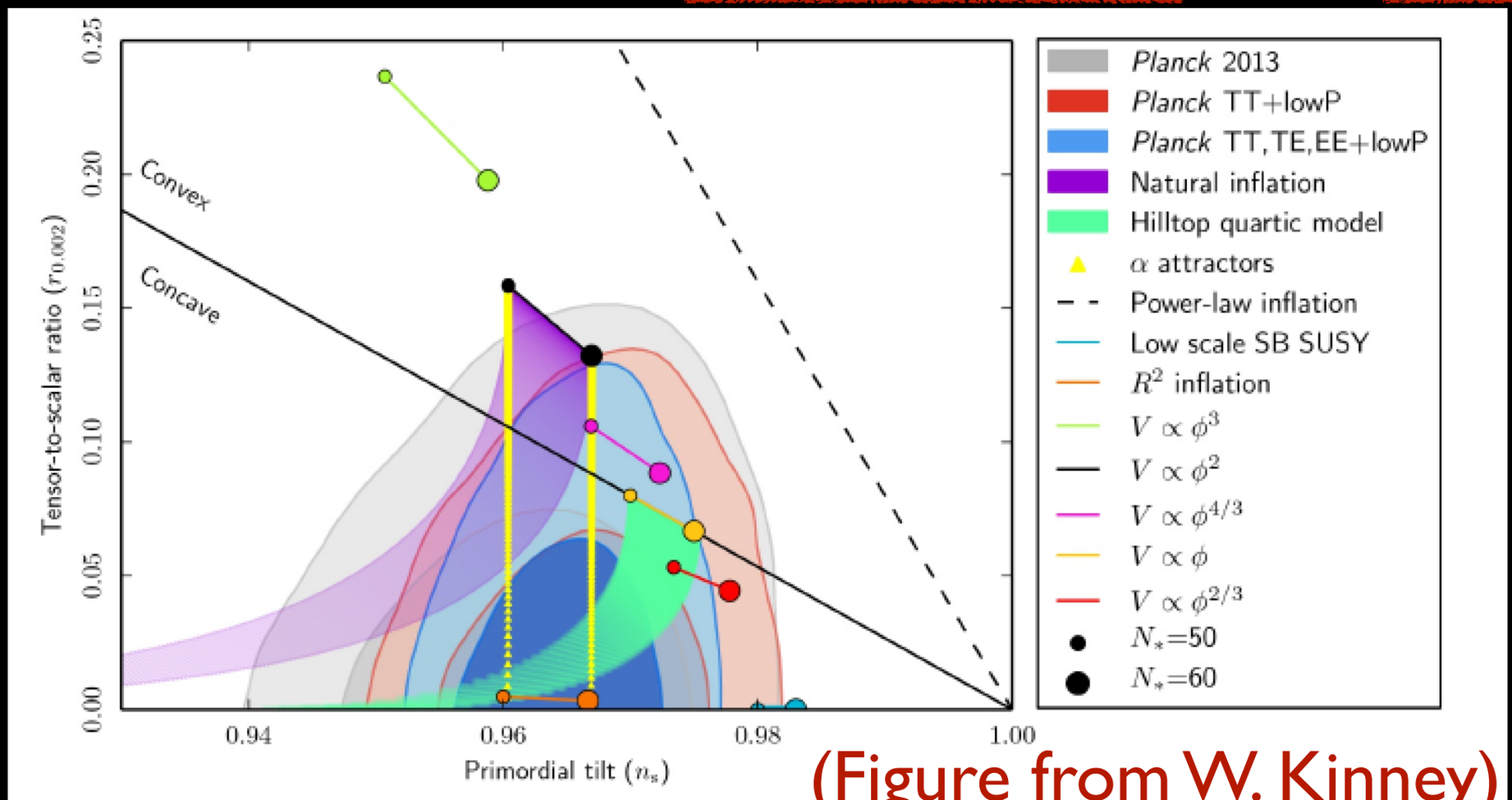
$$p + \rho \approx 0 \longrightarrow \text{constant Hubble rate } H$$

Single-field Inflation

$$\mathcal{L} = \frac{1}{2}\dot{\phi}^2 - U(\phi)$$

Requires

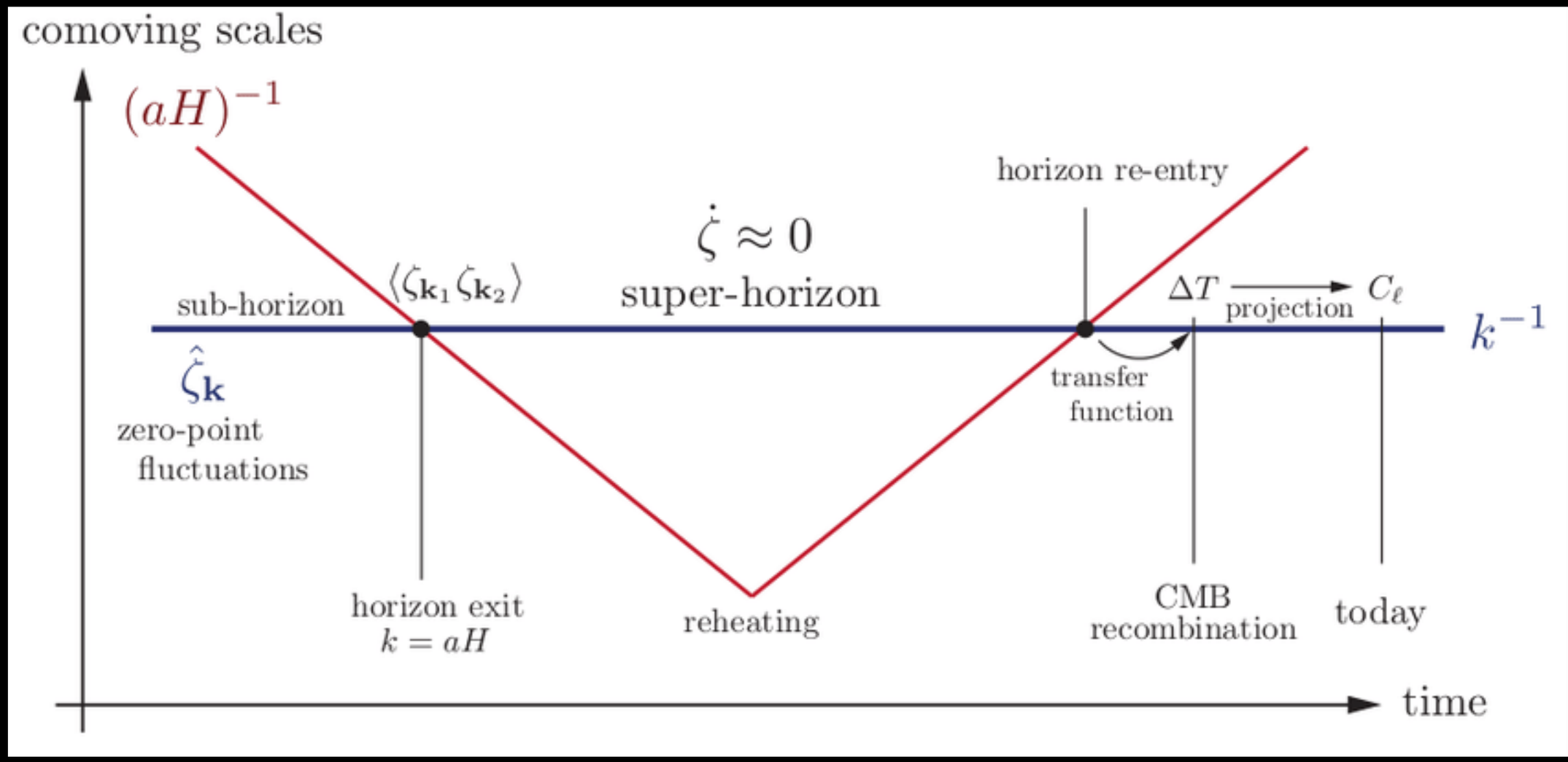
$$\frac{1}{2}\dot{\phi}^2 \ll U(\phi) \text{ and } \dot{H} \ll H^2$$



(Figure from W. Kinney)

Fig. 12. Marginalized joint 68 % and 95 % CL regions for n_s and $r_{0.002}$ from *Planck* in combination with other data sets, compared to the theoretical predictions of selected inflationary models.

Reheating can alter the observed e-fold number



Reheating can alter the observed e-fold number

$$N_{\rm hor} = 68.5 + \frac{1}{4}\ln\frac{V_{\rm hor}}{M_{\rm Pl}^4} + \frac{1}{4}\ln\frac{V_{\rm hor}}{\rho_{\phi,I}} + \frac{1}{12}\ln\frac{\rho_{\rm RH}}{\rho_{\phi,I}}$$

Inflation model — Reheating

Instantaneous reheating: $\rho_{\rm RH} = \rho_{\phi,I}$

$N_{\rm hor,0}$

Delayed reheating: $\rho_{\rm RH} < \rho_{\phi,I}$

$N_{\rm hor} < N_{\rm hor,0}$

Modeling reheating

The inflaton ϕ decays into relativistic degrees of freedom (radiation)

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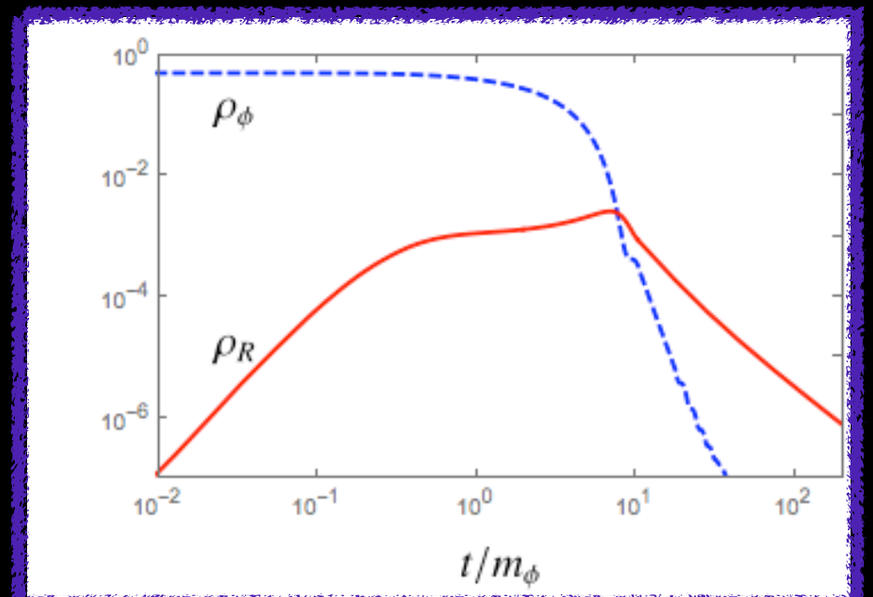
Reheating given by coupled Boltzmann equations:

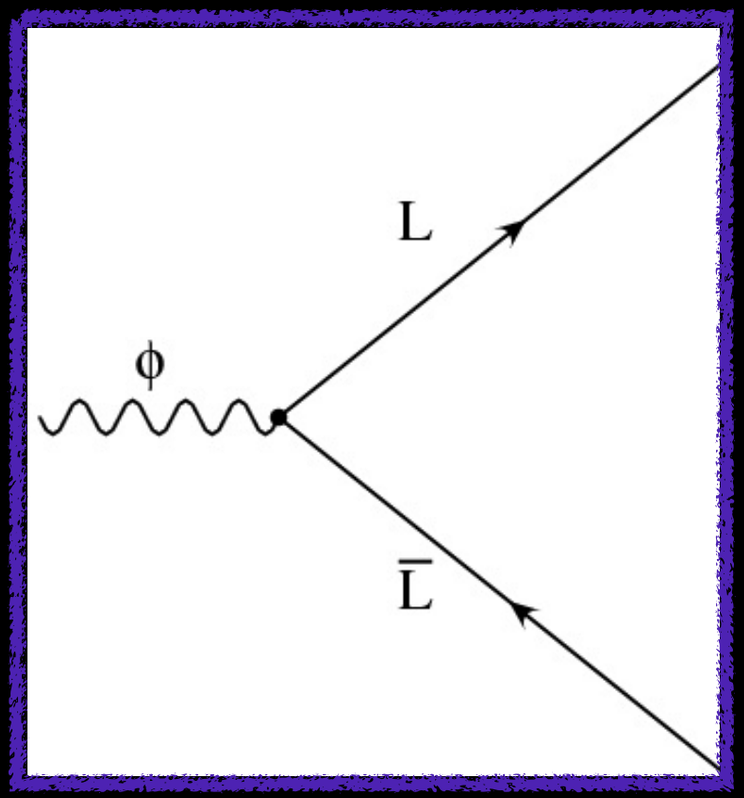
$$\ddot{\phi} + (3H + \Gamma)\,\dot{\phi} + m_\phi^2 \phi = 0$$

$$\dot{\rho}_R + 4H\rho_R = \Gamma\,\dot{\phi}^2$$



The damping term Γ transfers energy from the inflaton to radiation (relativistic SM particles)

Modeling reheating



The inflaton decays into massive (Higgsed) fermions or gauge bosons

$$\Gamma = \Gamma_0 \left(1 - \frac{4m_L^2}{m_\phi^2}\right)^{1/2}$$

$$m_L^2 = \frac{1}{2} y^2 h^2$$

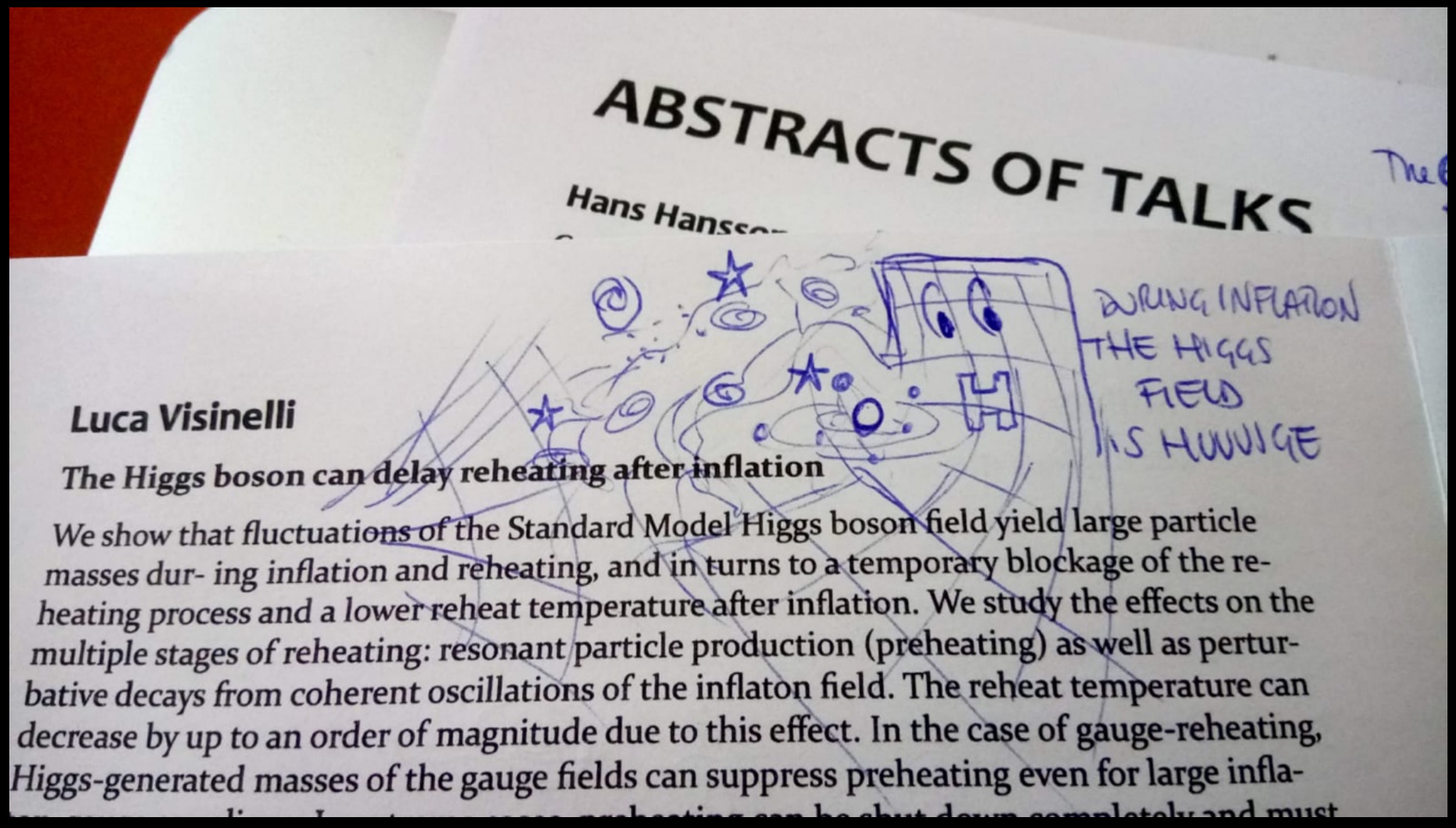
Yukawa coupling

Higgs field

Modeling reheating

But... the rms Higgs field during inflation is huge! (compared to EW scale)

$$h = \frac{H_I}{2\pi} \approx 10^{12}\,\mathrm{GeV}$$



ABSTRACTS OF TALKS

Hans Hansson

DURING INFLATION THE HIGGS FIELD IS HUUUGE

Luca Visinelli

The Higgs boson can delay reheating after inflation

We show that fluctuations of the Standard Model Higgs boson field yield large particle masses dur- ing inflation and reheating, and in turns to a temporary blockage of the reheating process and a lower reheat temperature after inflation. We study the effects on the multiple stages of reheating: resonant particle production (preheating) as well as perturbative decays from coherent oscillations of the inflaton field. The reheat temperature can decrease by up to an order of magnitude due to this effect. In the case of gauge-reheating, Higgs-generated masses of the gauge fields can suppress preheating even for large infla-

Delaying inflation

$$\Gamma = \Gamma_0 \left(1 - \frac{y^2 h^2}{m_\phi^2}\right)^{1/2}$$

For large values of the Higgs the decay rate is suppressed!