Insufficient Fermion (P)reheating in a Quartic Inflaton Potential

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Based on hep-ph/250x.xxxxx in collaboration with
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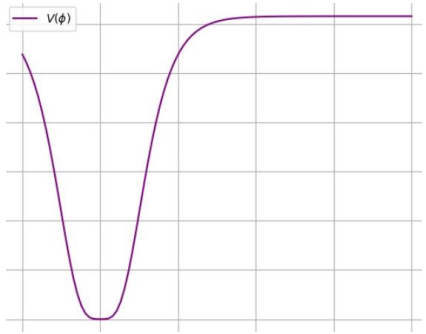
Consider a potential with quartic minimum, i.e set k=4



$$V(\phi) = \lambda M_P^4 \left(\sqrt{6} \tanh \left(\frac{\phi}{\sqrt{6} M_P} \right) \right)^k$$

A Lagrangian with

$$\mathcal{L}_{\text{int}} = y \phi \bar{\psi} \psi$$

Goals ?

- Determine the range of couplings, y, to achieve reheating
- Perform a full non-perturbative analysis including backrection and fragmentation effects
- Compare with Perturbative expectation

- **Perturbative:** particle production (wavelengths < Hubble scale) from classical oscillating inflaton (impossible to account for Pauli-Blocking correctly)

- **Non-perturbative:** gravitational production of fermion quanta out of the background, accounting for Pauli Blocking and all wavelengths

What we found?

- Fermions have to be treated non-perturbatively from couplings as small as 0.0000001 (seems perturbative)

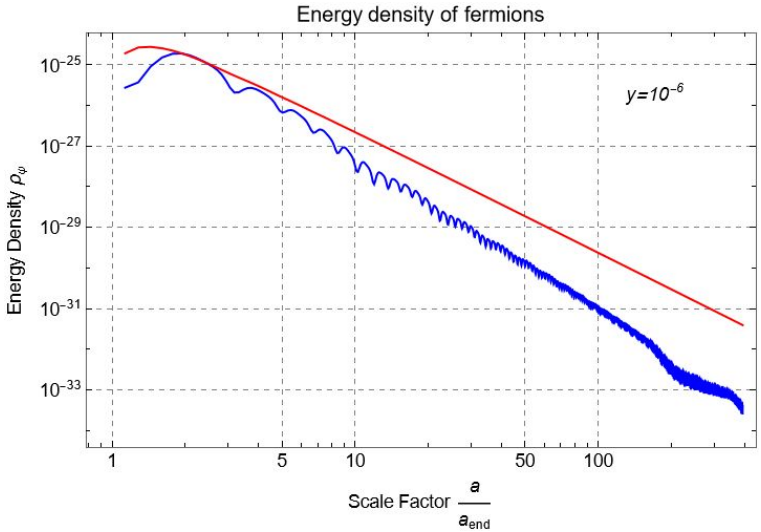


Fig 1. Perturbative expectation (red) and non-perturbative (blue) fermion energy density

- Pauli Blocking in the phase space distribution (PSD) is reached at these low couplings in the IR

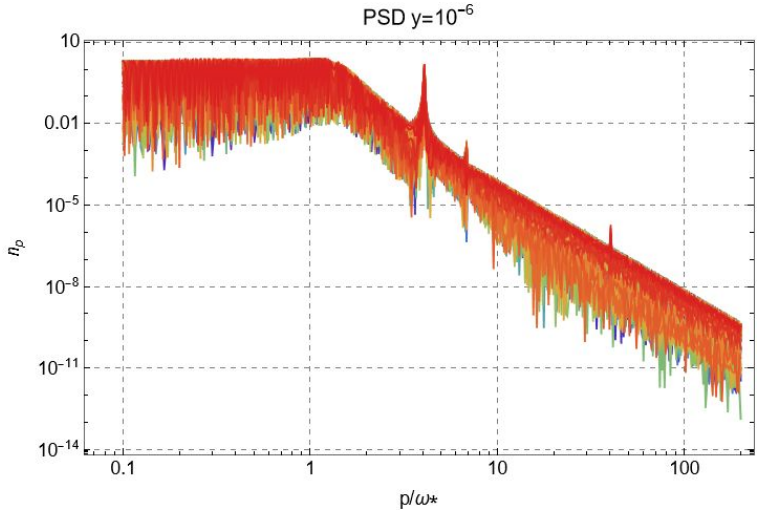


Fig 2. PSD of fermion (occupation number n_p) vs. momentum modes

What we found?

- Reheating to purely fermions in ***quartic*** inflaton potentials seems to be (I will wait for the paper to say it is) impossible:

  → For small coulings (perturbative regime), you do not produce enough fermions to reheat (BBN Bound)

  → For moderate couplings, post-fragmentation perturbative decays of inflaton fluctuations is kinematically suppressed resulting in unsuccessful reheating

  → For large > O(0.1) couplings, preheating effects lead to the need for backreaction to be considered

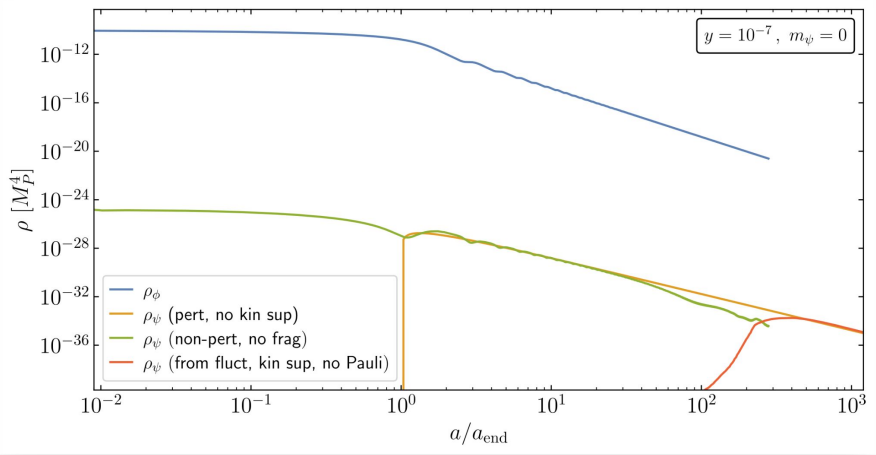


Fig 3: example of a full analysis

My trajectory: Born in Nepal → Grew up in India → Now in Hamburg, Germany

1st year PhD student at DESY.

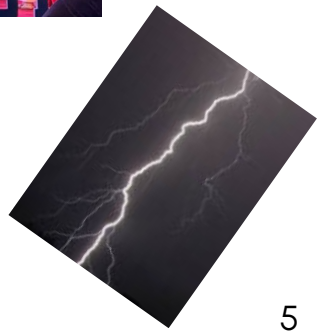
Physics: Early Universe Cosmology

Hobbies: Music, the gym and sports, and cooking

house I was born in

Nabeen

Fun fact: Lightning did not give me superpowers :(



THANK YOU