Gravitational waves from Standard Model*Axion*Seesaw*Higgs portal inflation

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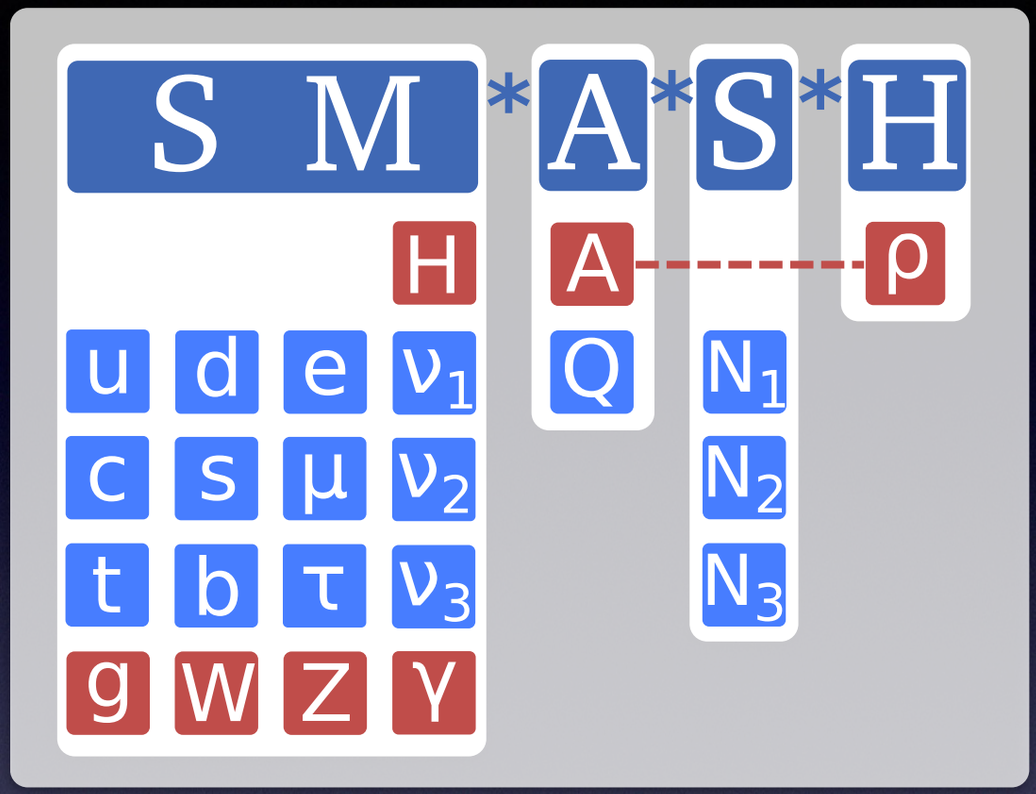
The SMASH model

- Proposed model based on a simple extension of the SM that addresses five fundamental problems in particle physics and cosmology:

  1. Inflation
  2. Baryon asymmetry
  3. Neutrino masses
  4. Dark matter
  5. Strong CP problem



Standard Model*Axion*Seesaw*Higgs portal inflation (SMASH)

[Ballesteros, Redondo, Ringwald and Tamarit (2017)]

- This work:
  Focus on the spectrum of primordial gravitational waves (GWs) originating from tensor fluctuations during inflation.

  - Predictive (dynamics during inflation + thermal history after inflation)
  - Observable (future high-sensitivity direct/indirect detection experiments)

Prediction for the Peccei-Quinn phase transition

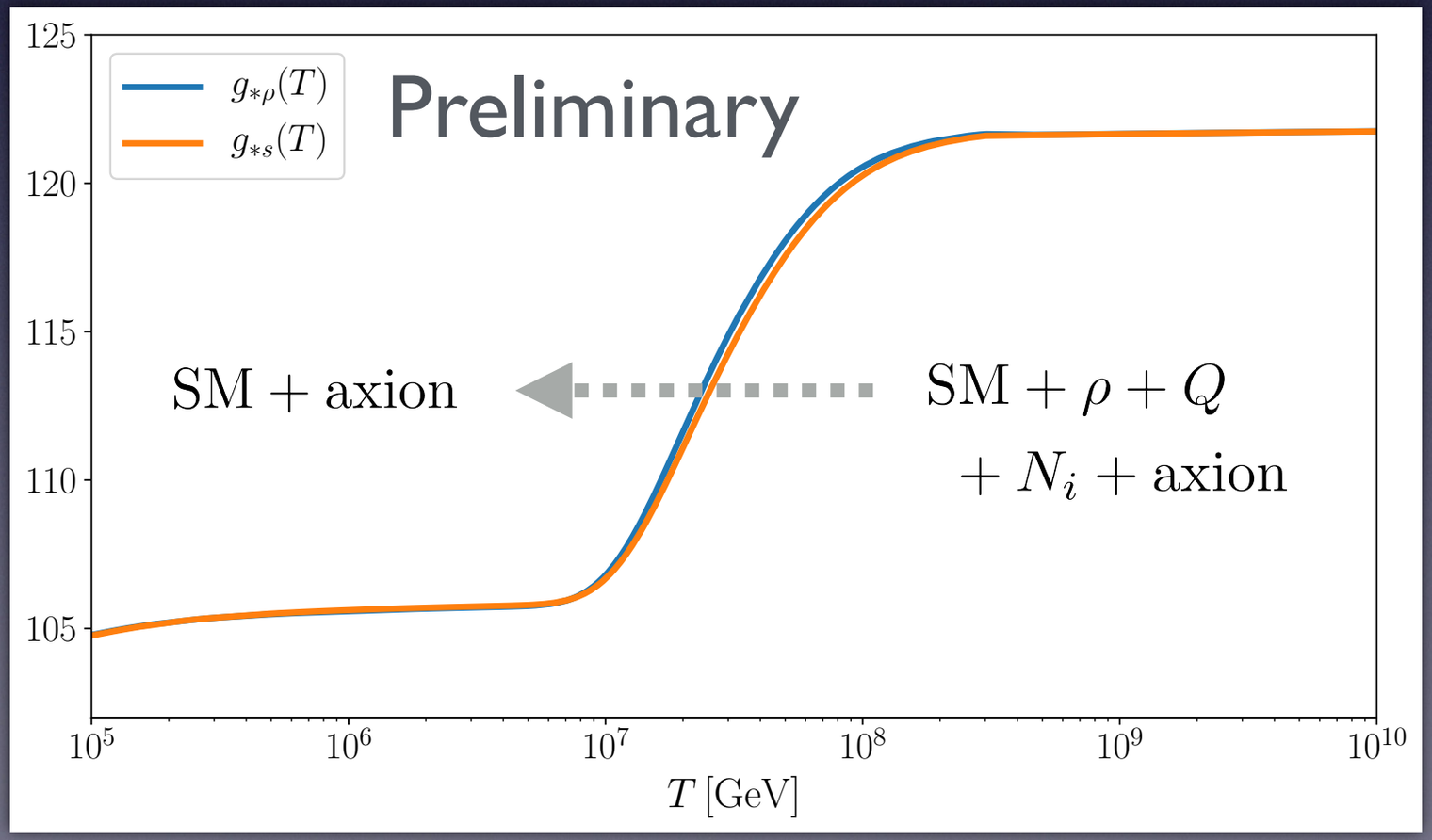
- A unique prediction for critical temperature of the PQ phase transition:

$$T_c \sim \lambda^{1/4} f_a \sim \mathcal{O}(10^7\text{–}10^8)\,\mathrm{GeV}$$

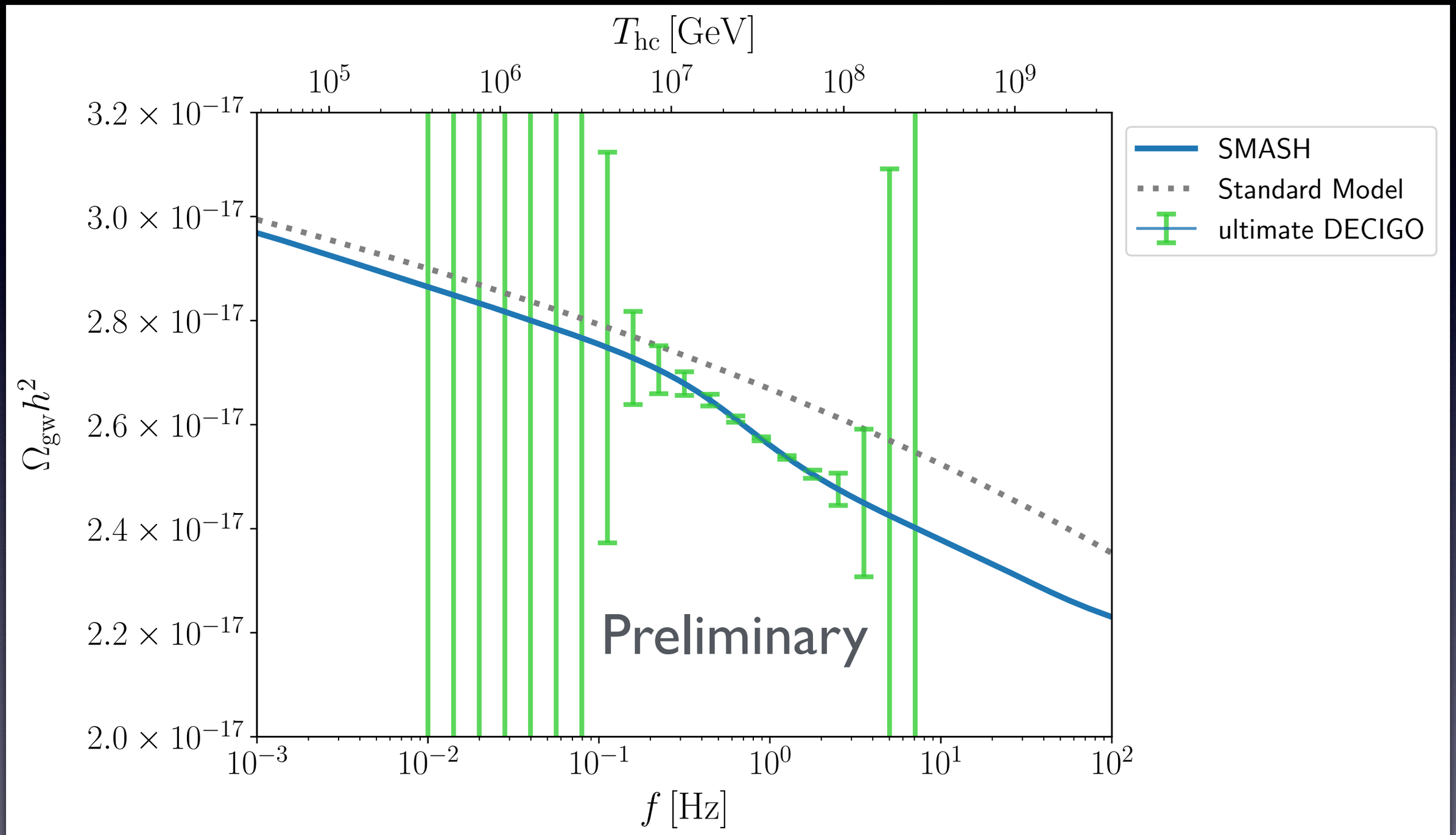
Vacuum stability and inflation ➡ $5 \times 10^{-13} \lesssim \lambda \lesssim 5 \times 10^{-10}$ for self-coupling of the PQ field

Dark matter ➡ $f_a \sim 10^{11}\,\mathrm{GeV}$ for PQ/seesaw scale

- Change of the equation of state around $T_c \sim \mathcal{O}(10^7\text{–}10^8)\,\mathrm{GeV}$.



Spectrum of gravitational waves



Step in the GW spectrum due to the change of equation of state around the PQ phase transition can be probed in future GW direct detection experiments.