University of Zurich[UZH]

Dynamic DM Production

Finite Temperature Effects and the Vev Flip Flop

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MITP, 21 June 2018

Based on 1608.07578 (PRL)
and 1712.03962 (JHEP)
MJB, M. Breitbach, L. Mittnacht, J. Kopp

- Overview

In this talk we will discuss three BSM scenarios:

- Kinematically induced freeze-in
- Vev induced freeze-in
- Decaying dark matter

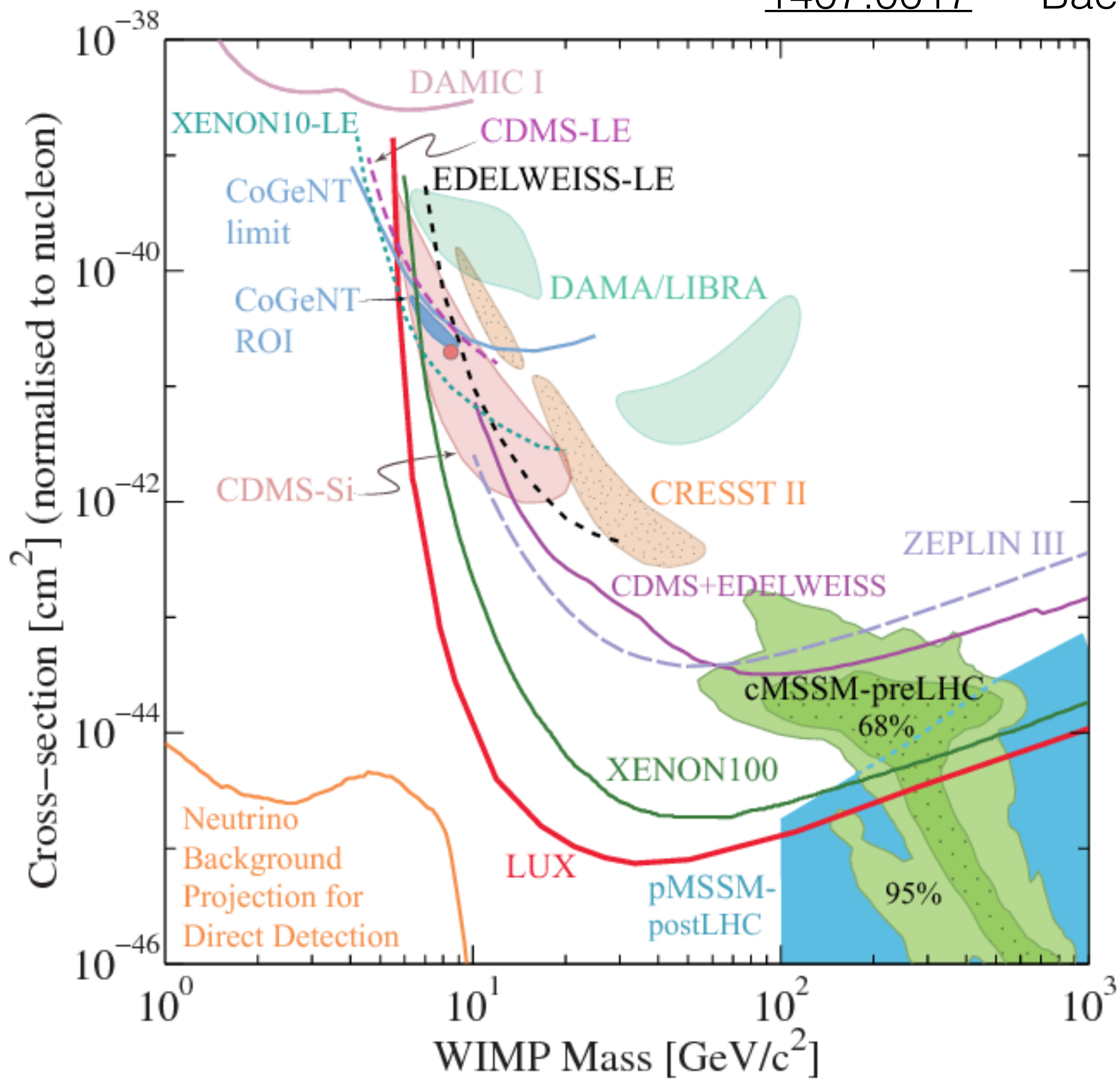
Our main tools will be:

- The effective potential at finite temperature
- Boltzmann equations

Freeze-out and Freeze-in

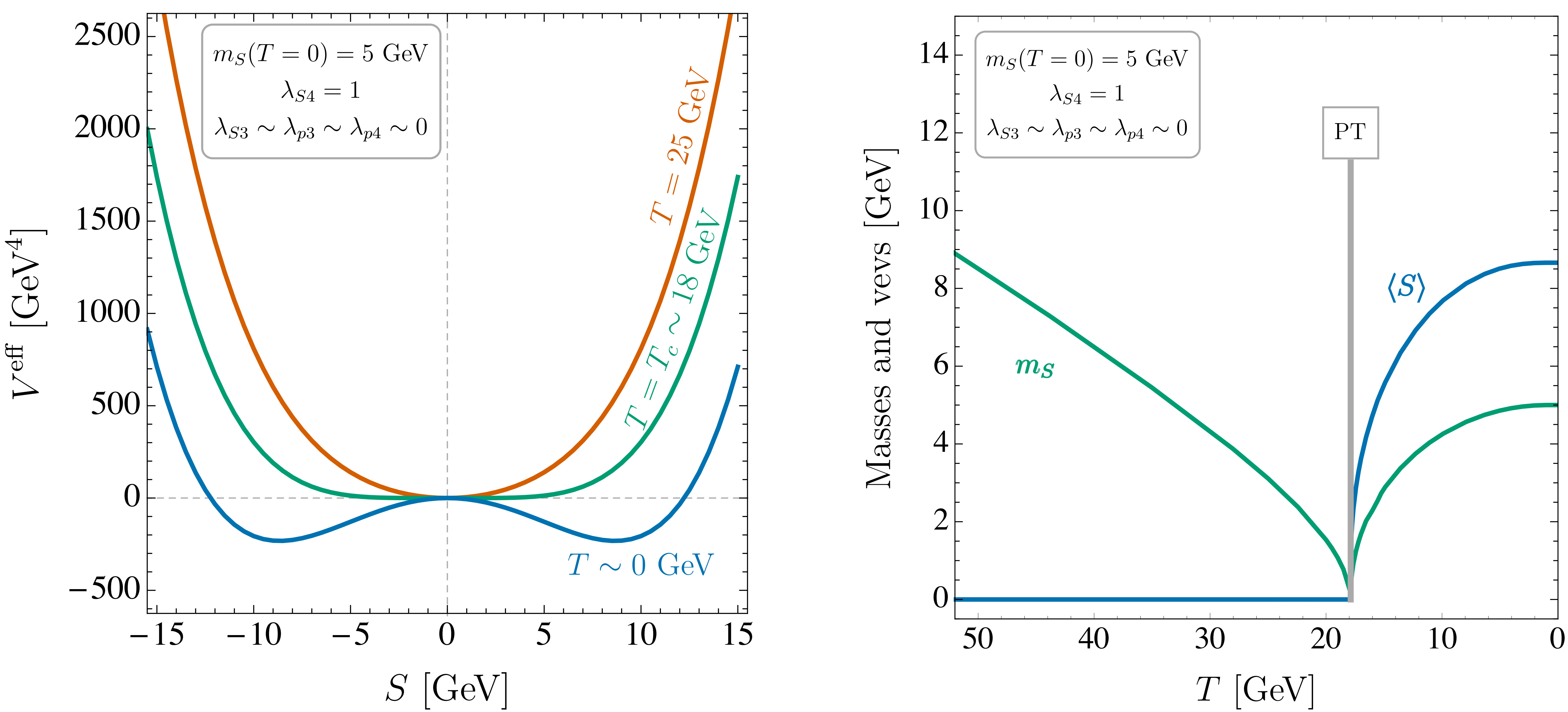
- The thermal WIMP paradigm

1407.0017 — Baer, Howard et al.

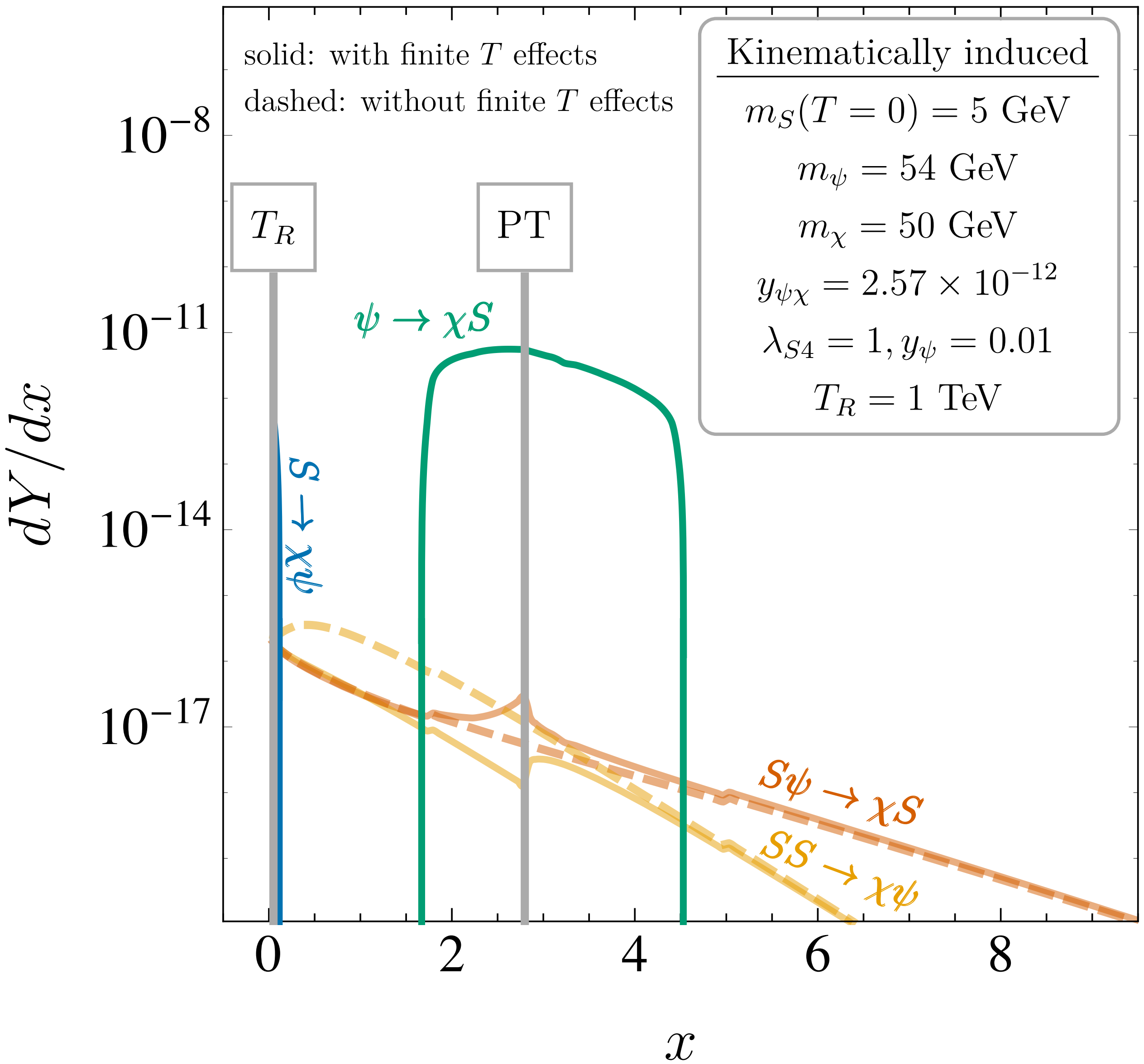


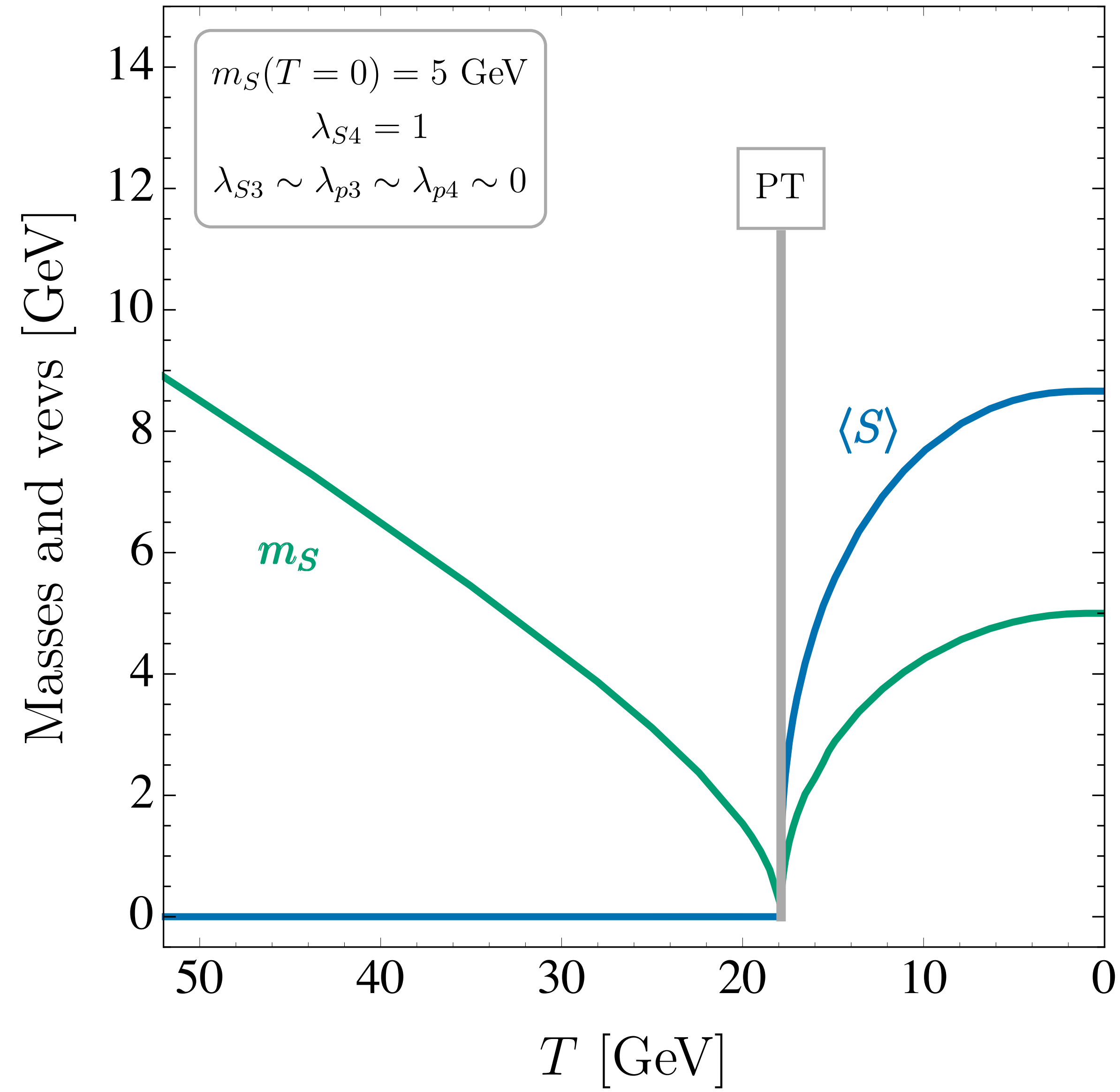
Kinematically Induced Freeze-in

- The Effective Potential - Second Order PT



• Kinematically Induced Freeze-in - Results





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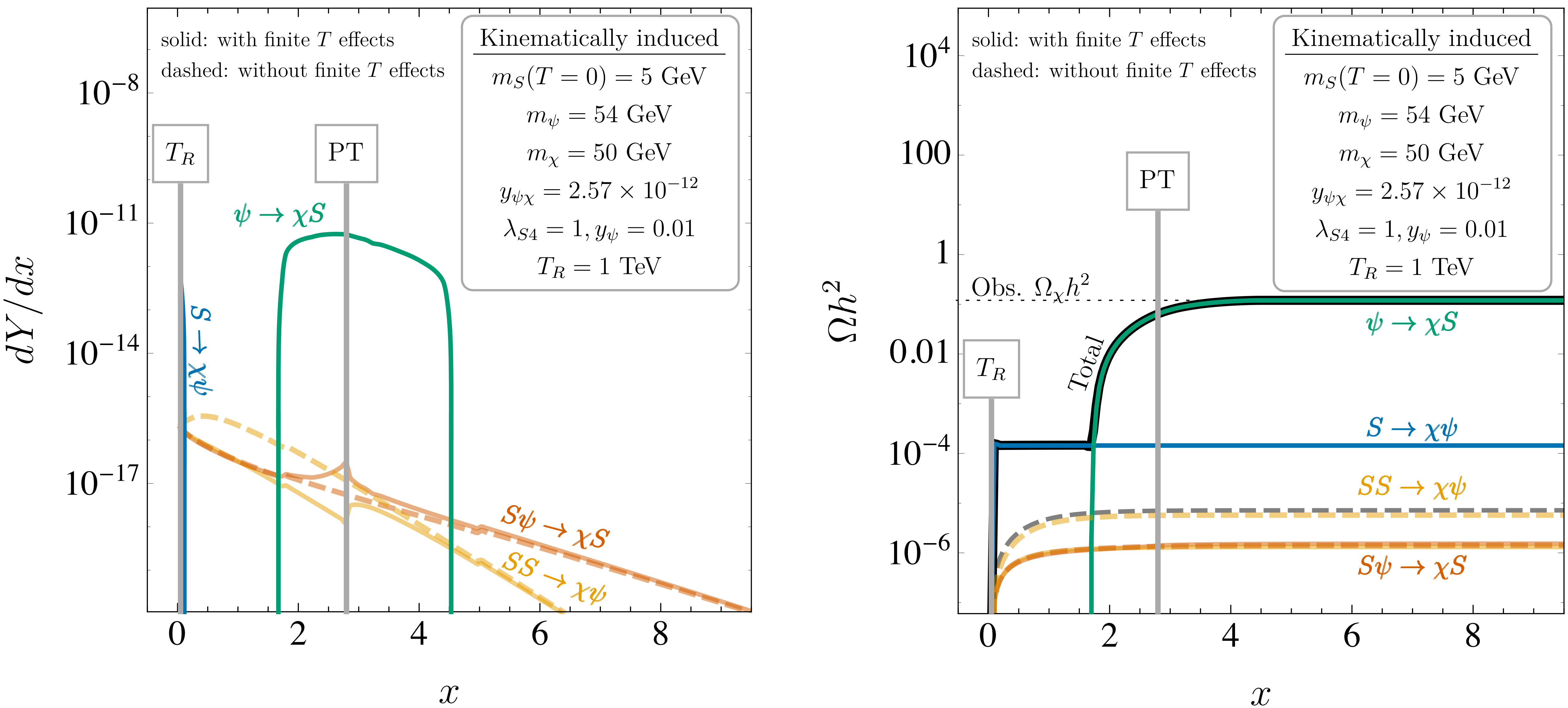
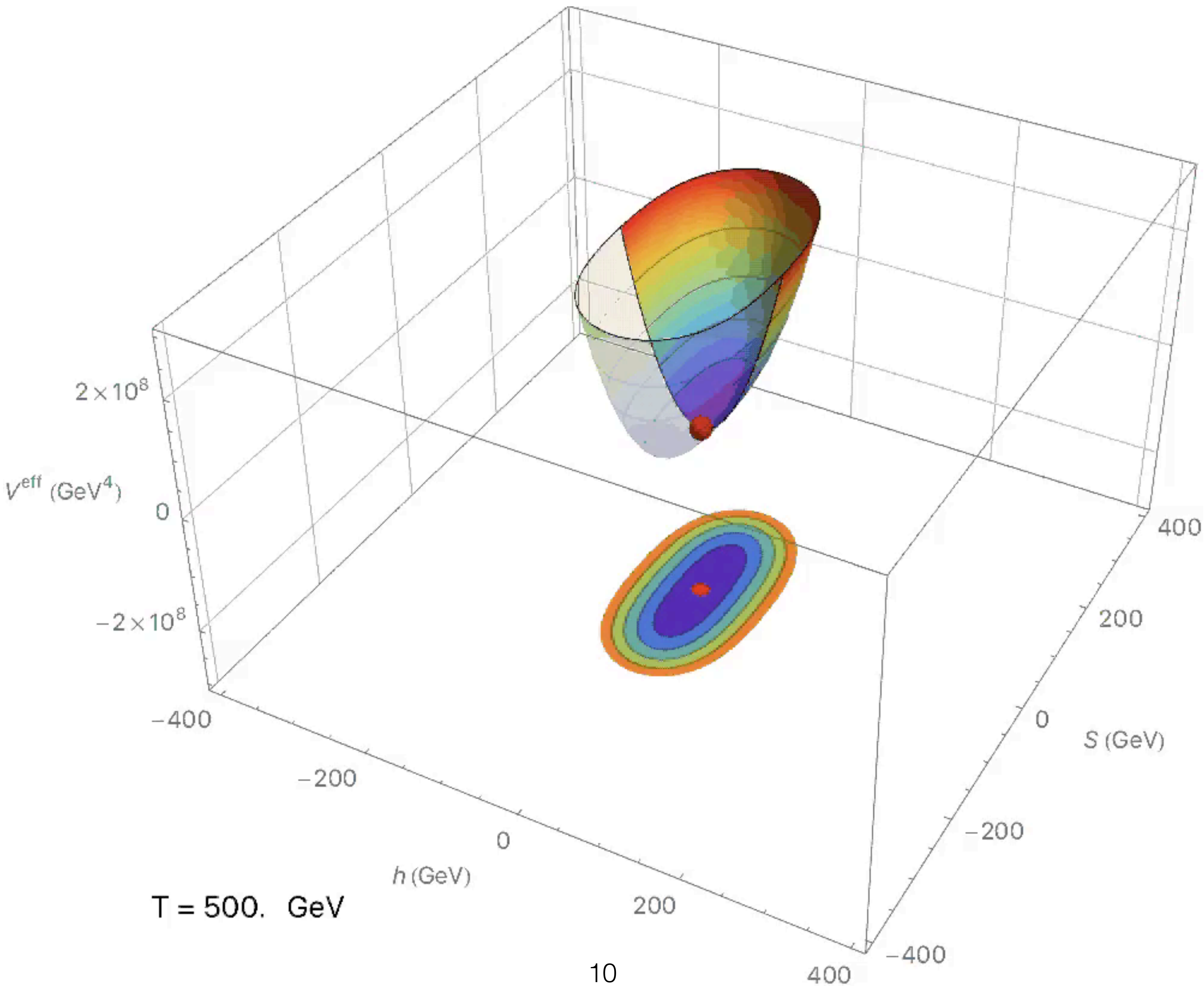


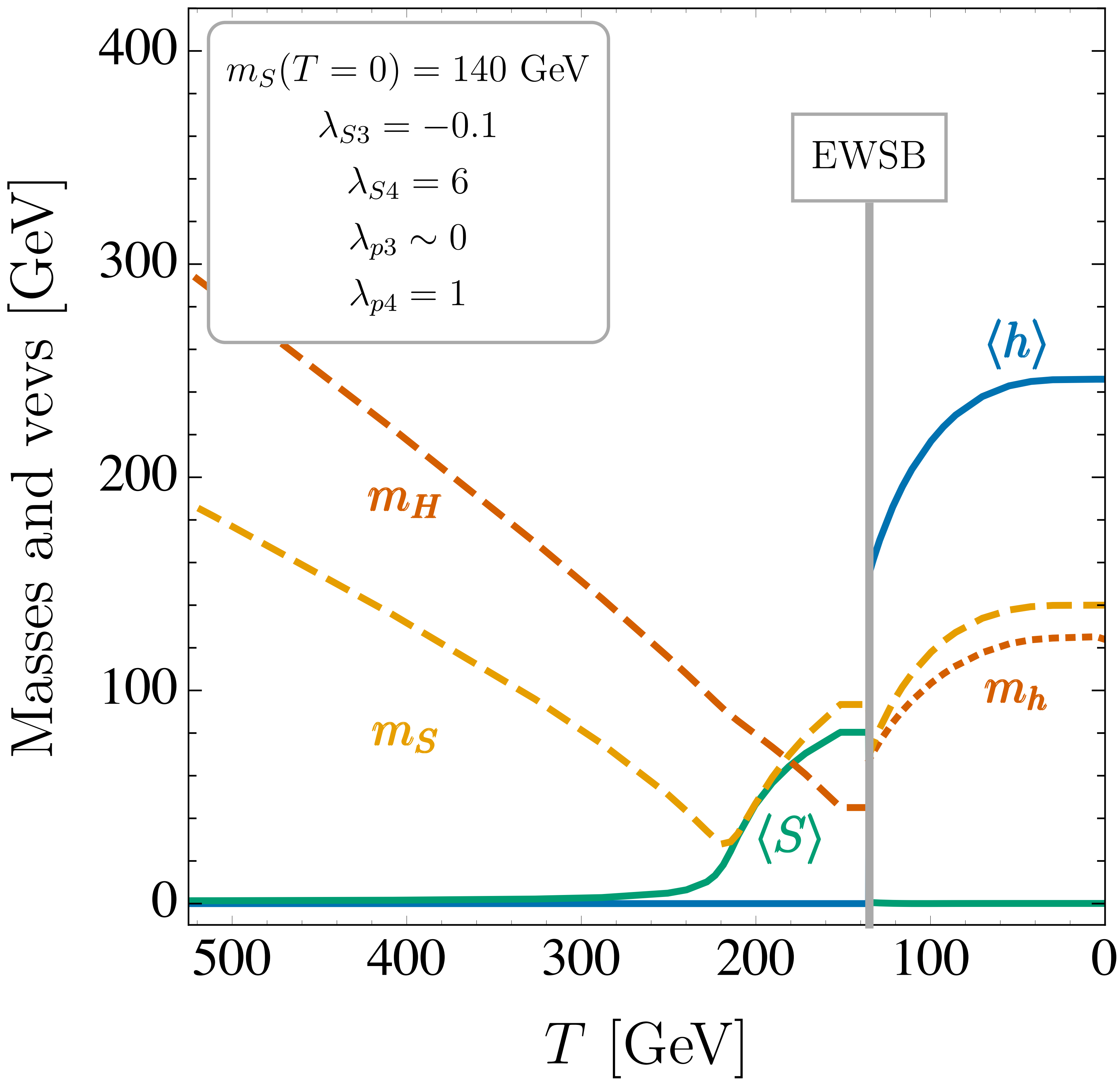
Thermal effects increase relic abundance by orders of magnitude

Vev Induced Freeze-in

- Vev Flip-Flop: Effective Potential

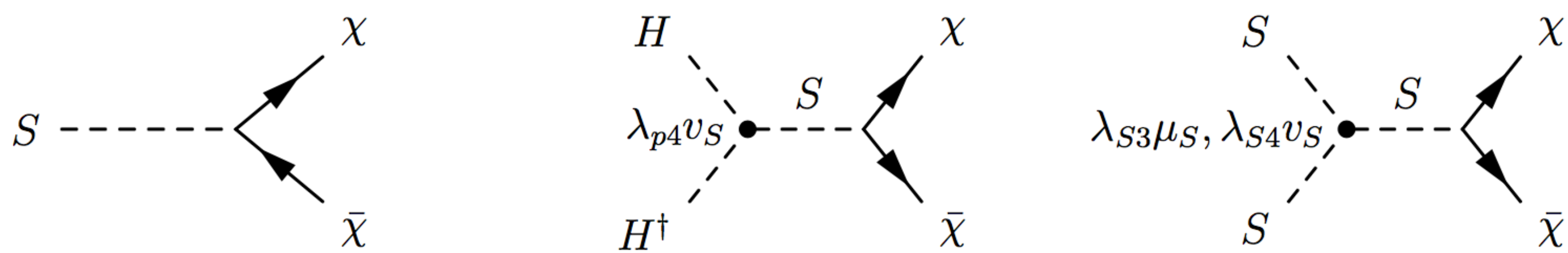


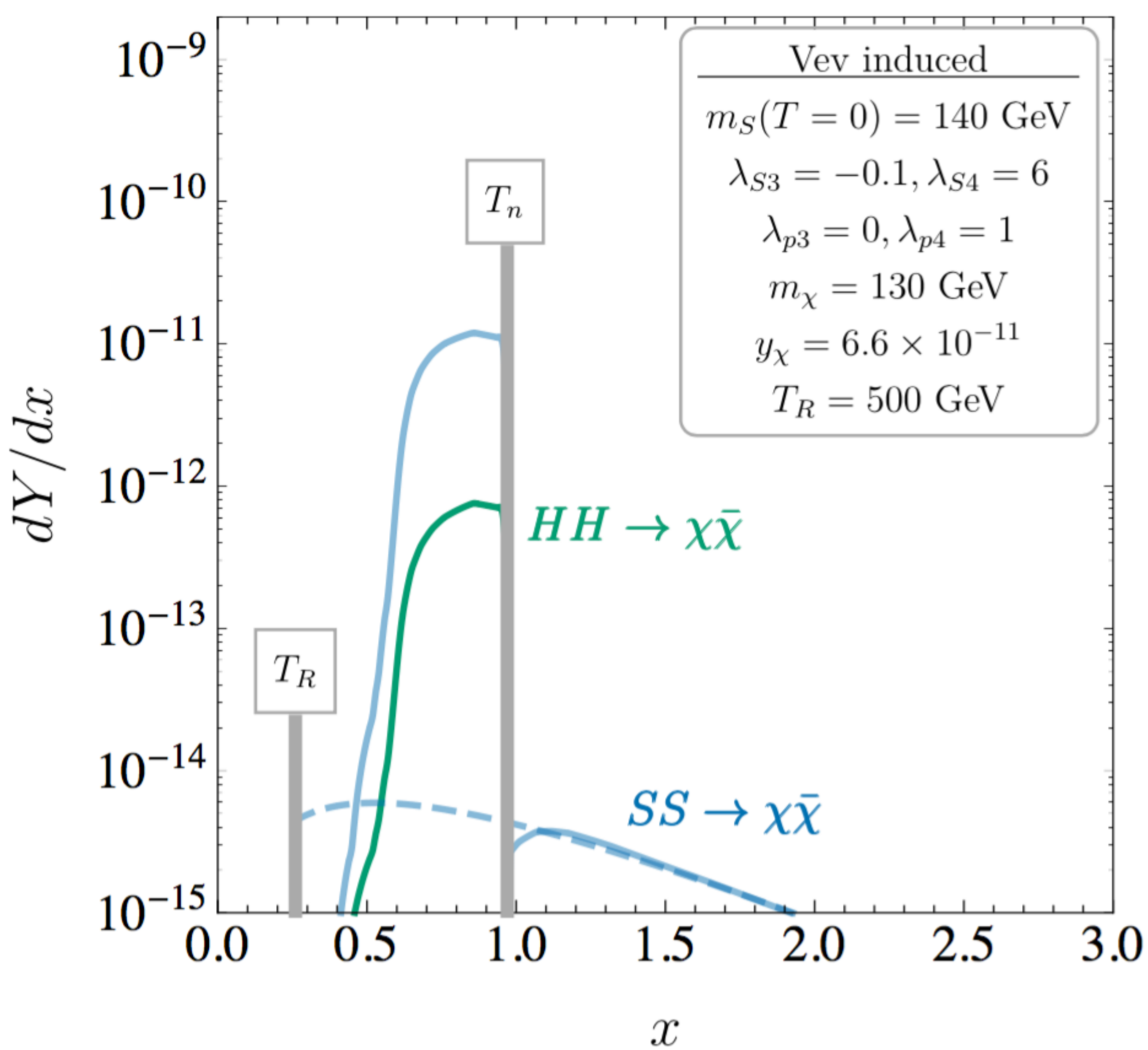
- Vev Induced Freeze-in

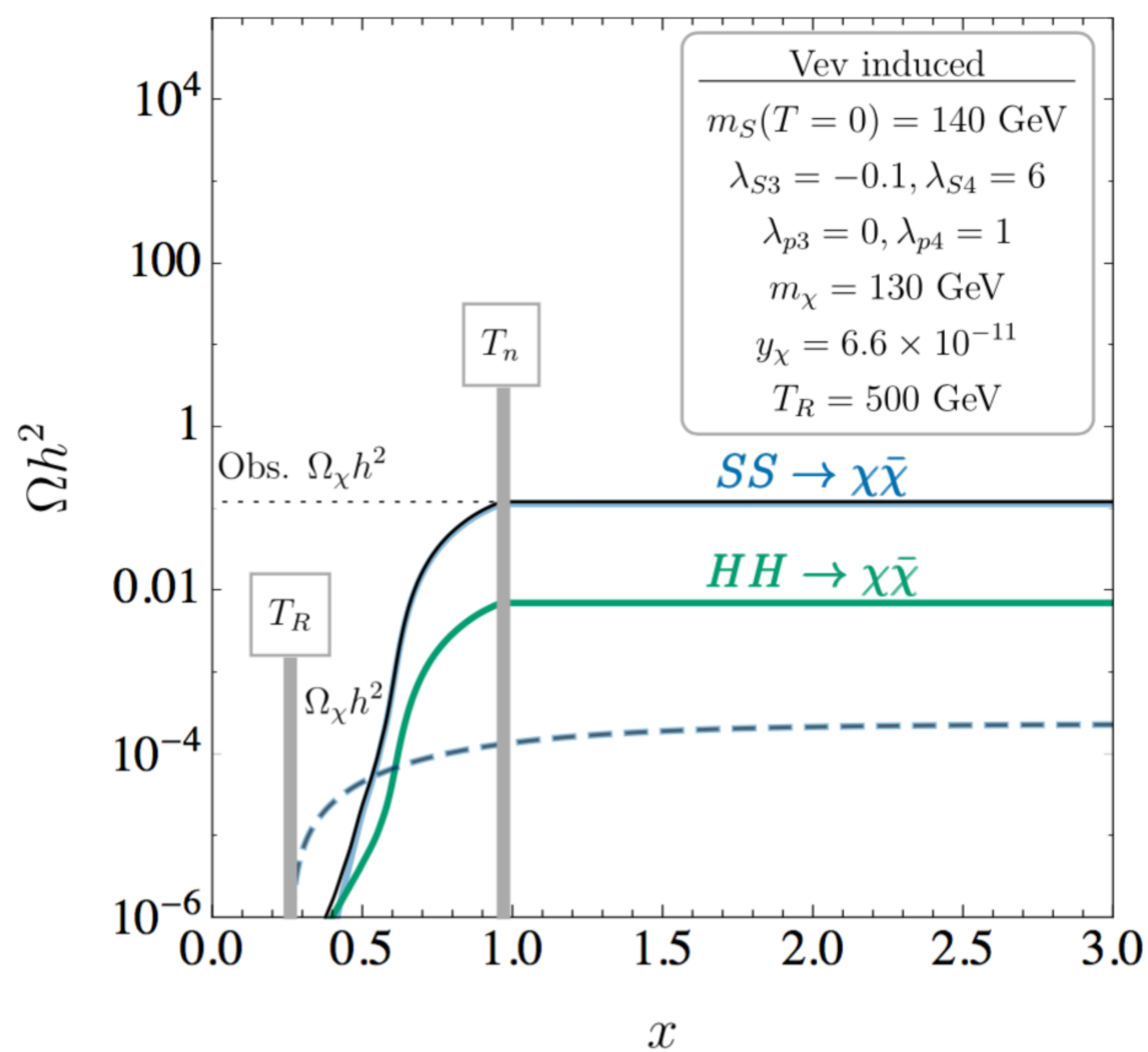


- Vev Induced Freeze-in

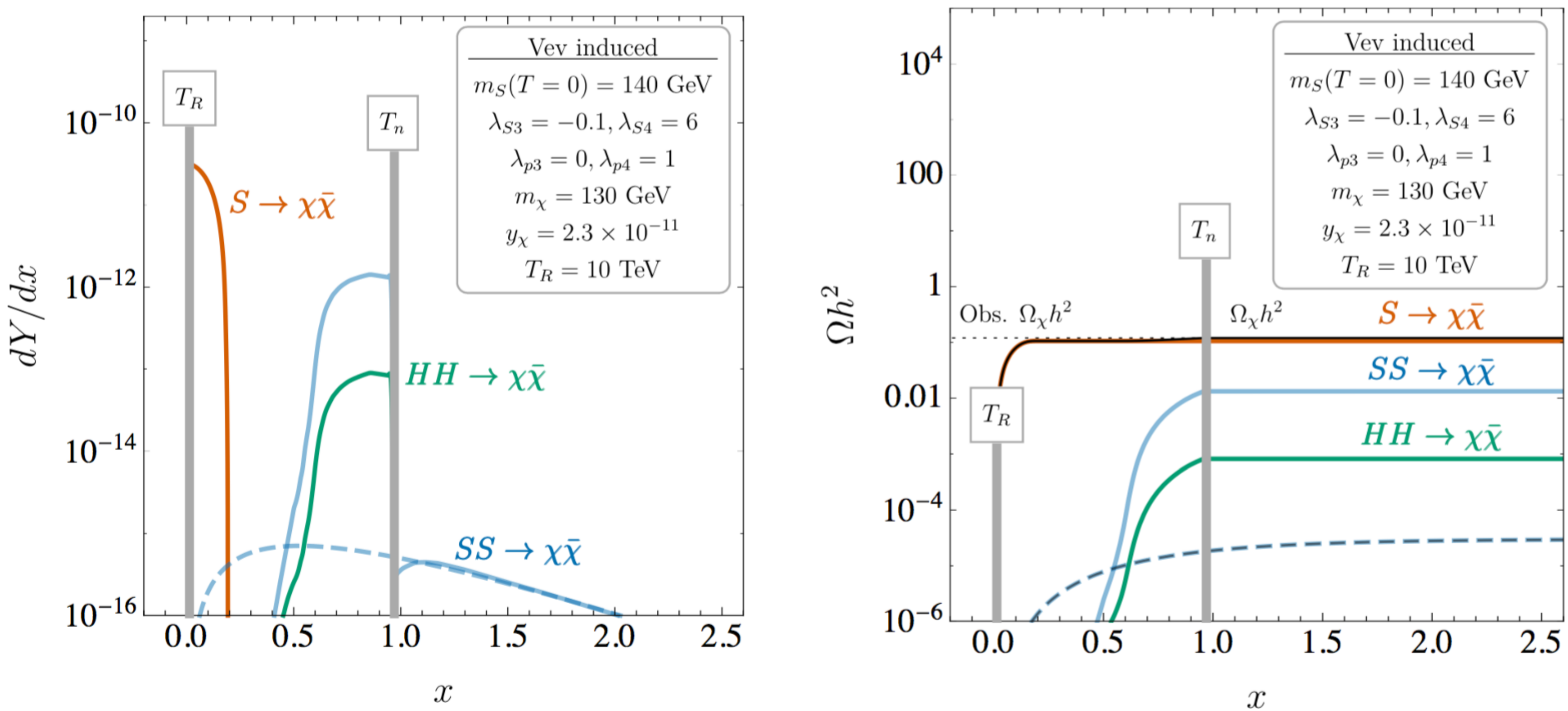
Again, assume χ begins with negligible abundance







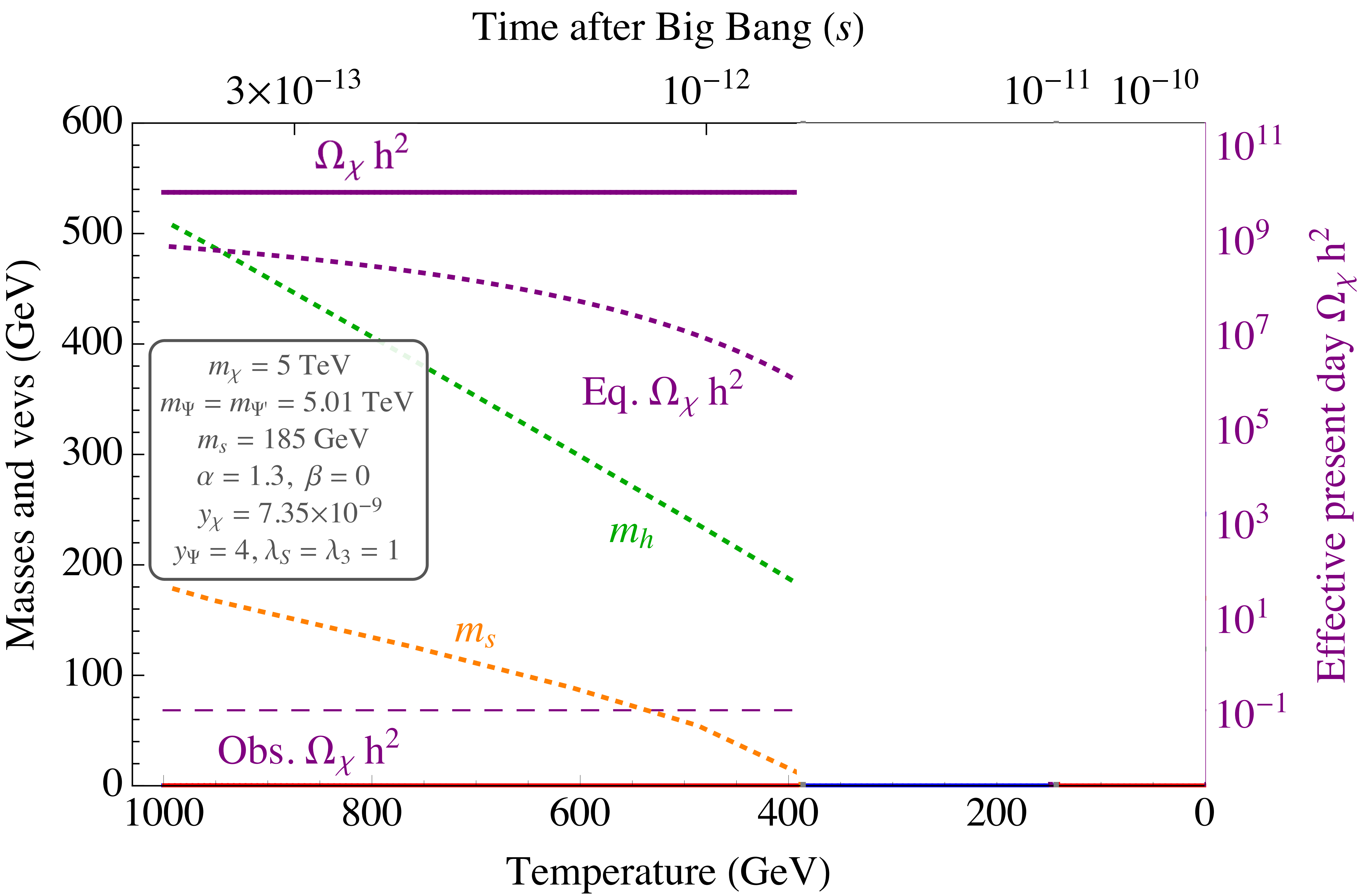
- Vev Induced Freeze-in



Thermal effects increase relic abundance by orders of magnitude

Decaying Dark Matter

- Vev Flip-Flop: Dark Matter Decay



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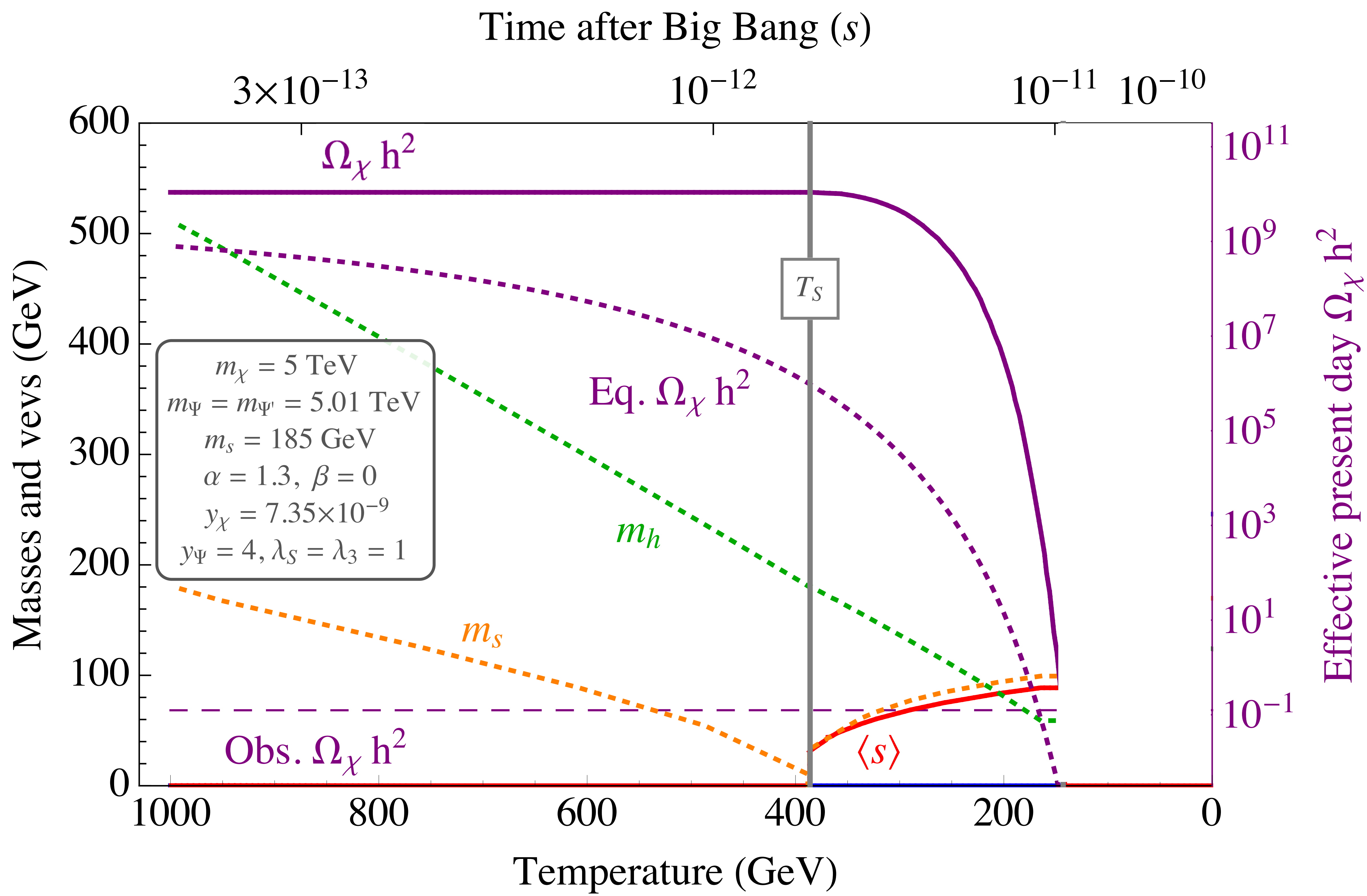
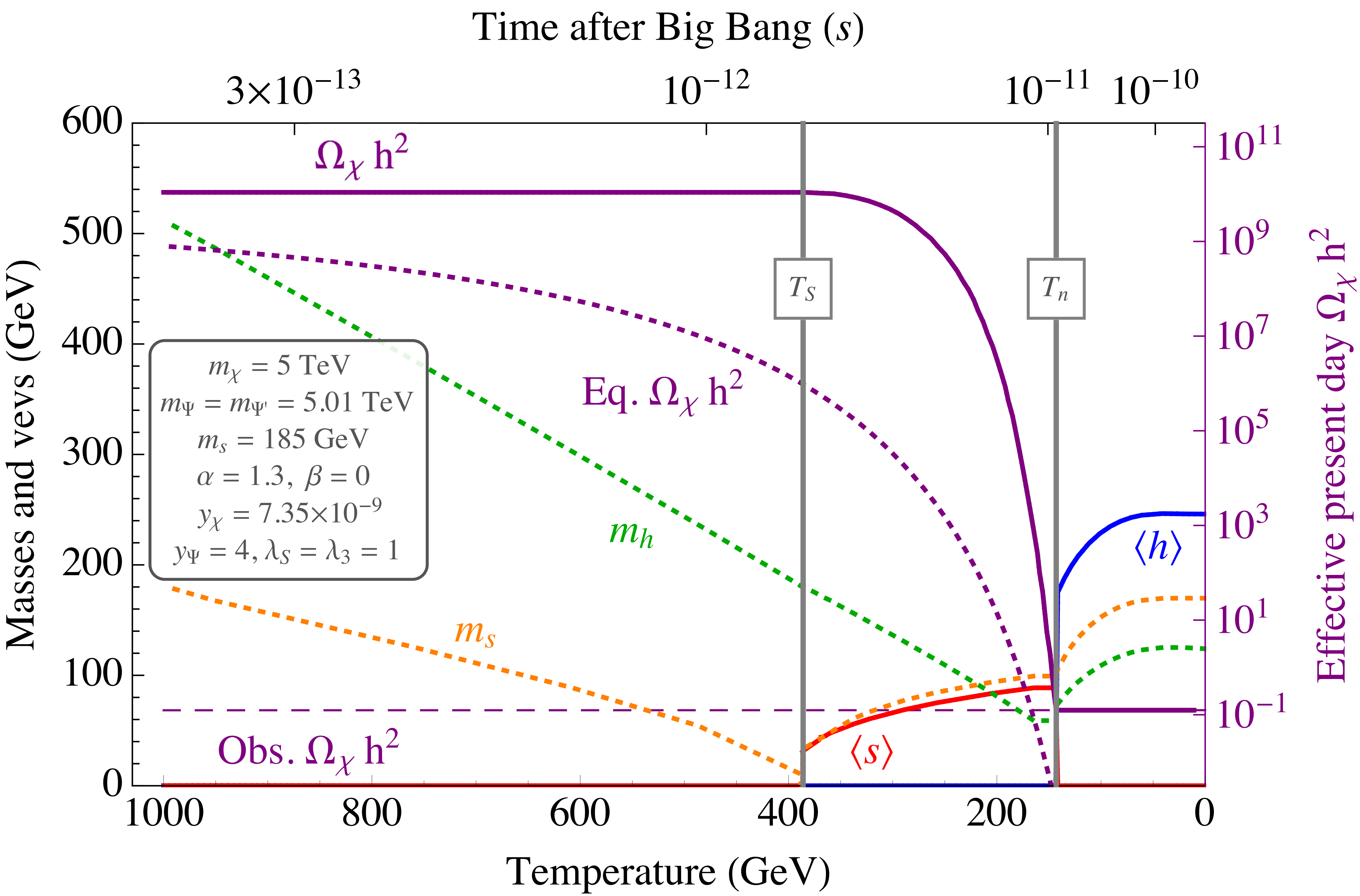
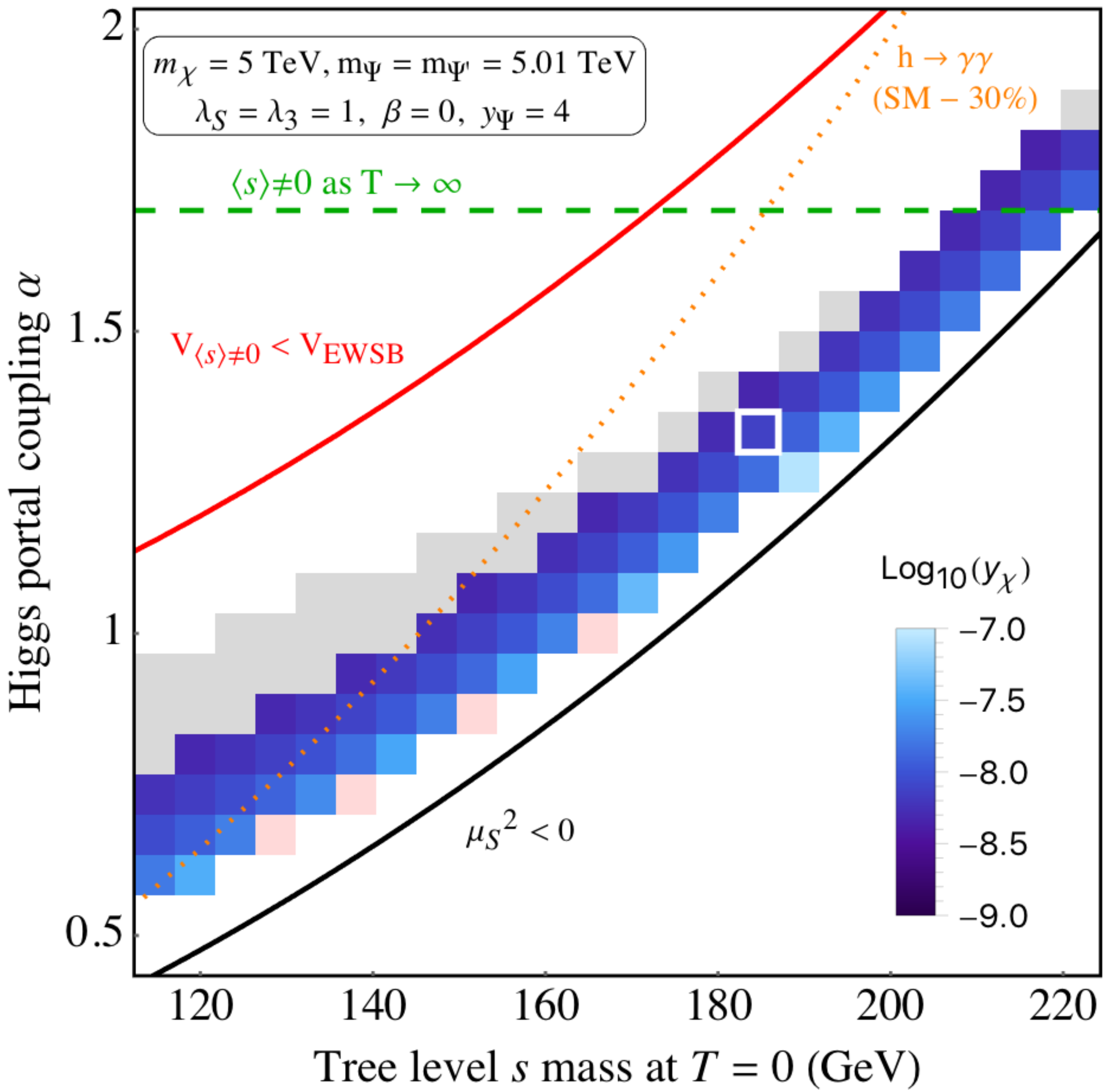


- Vev Flip-Flop: Dark Matter Decay



New production mechanism, determined by finite temperature effects

- Vev Flip-Flop: Parameter Space



• Conclusions

- Thermal effects are important in the early universe!
- Temperature dependent masses affect kinematic thresholds
- NP scalars may temporarily obtain vevs
- All this can have a dramatic influence on DM abundance!
- Illustrated this with three toy models
- Outlook:
  - More realisations,
  - LHC phenomenology,
  - gravitational wave signals,
  - baryogenesis,…

- Vev Flip-Flop: Possible tests

Direct and Indirect Detection

Detection of χ hindered by small couplings

Best prospect from subdominant population of s, Ψ^0, Ψ'^0

Drell-Yan production of $s^\pm$ pairs, followed by $s^\pm \to s + W^{*\pm}$

Small mass splitting implies soft decay products

Mono-X is several orders of magnitude too weak

Possibilities in disappearing charged tracks