Early Dark Energy During Big Bang Nucleosynthesis
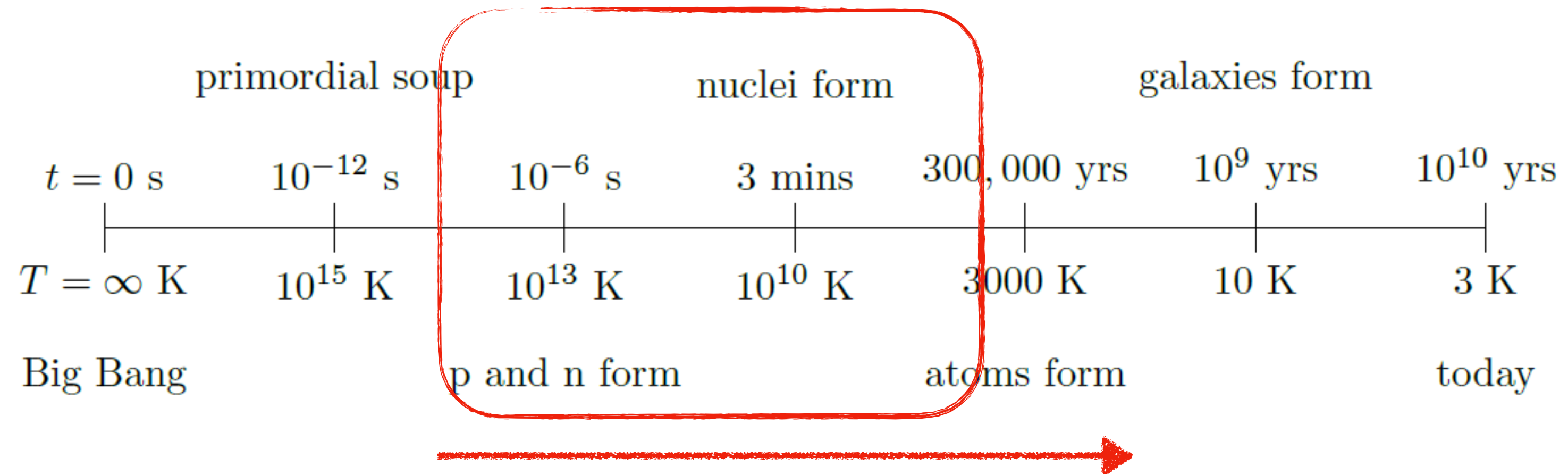
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Early Dark Energy During Big Bang Nucleosynthesis

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Or simply: EDE During BBN
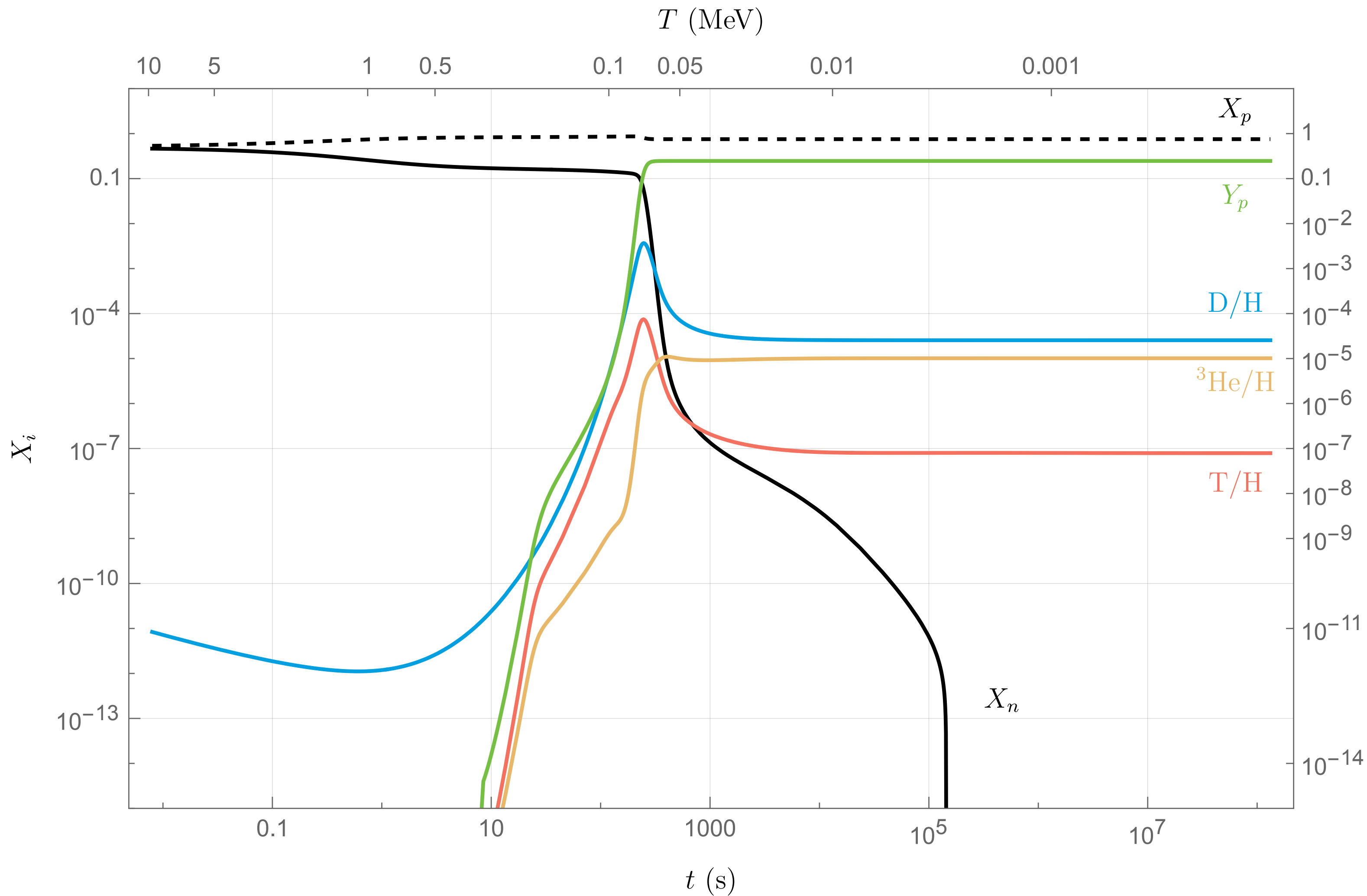
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Standard Big Bang Nucleosynthesis

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Standard Big Bang Nucleosynthesis

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[Cyburt et al, 2016]

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Can we vary dark energy at this time?

(recent DESI results, Hubble tension,..)

$\rho_r \propto a^{-4}$

$\rho_m \propto a^{-3}$

$\rho_{CC} \propto a^0$

BBN
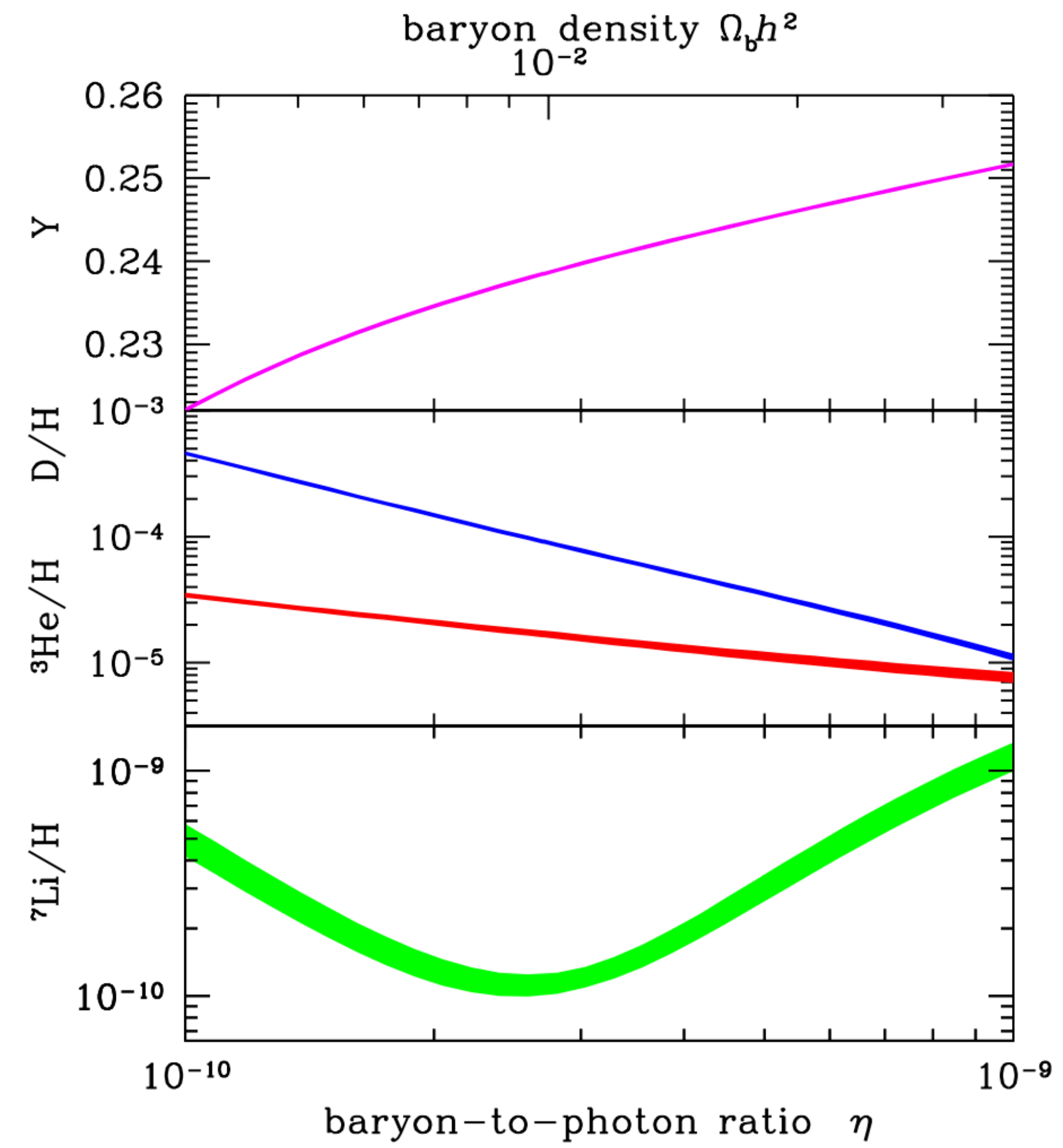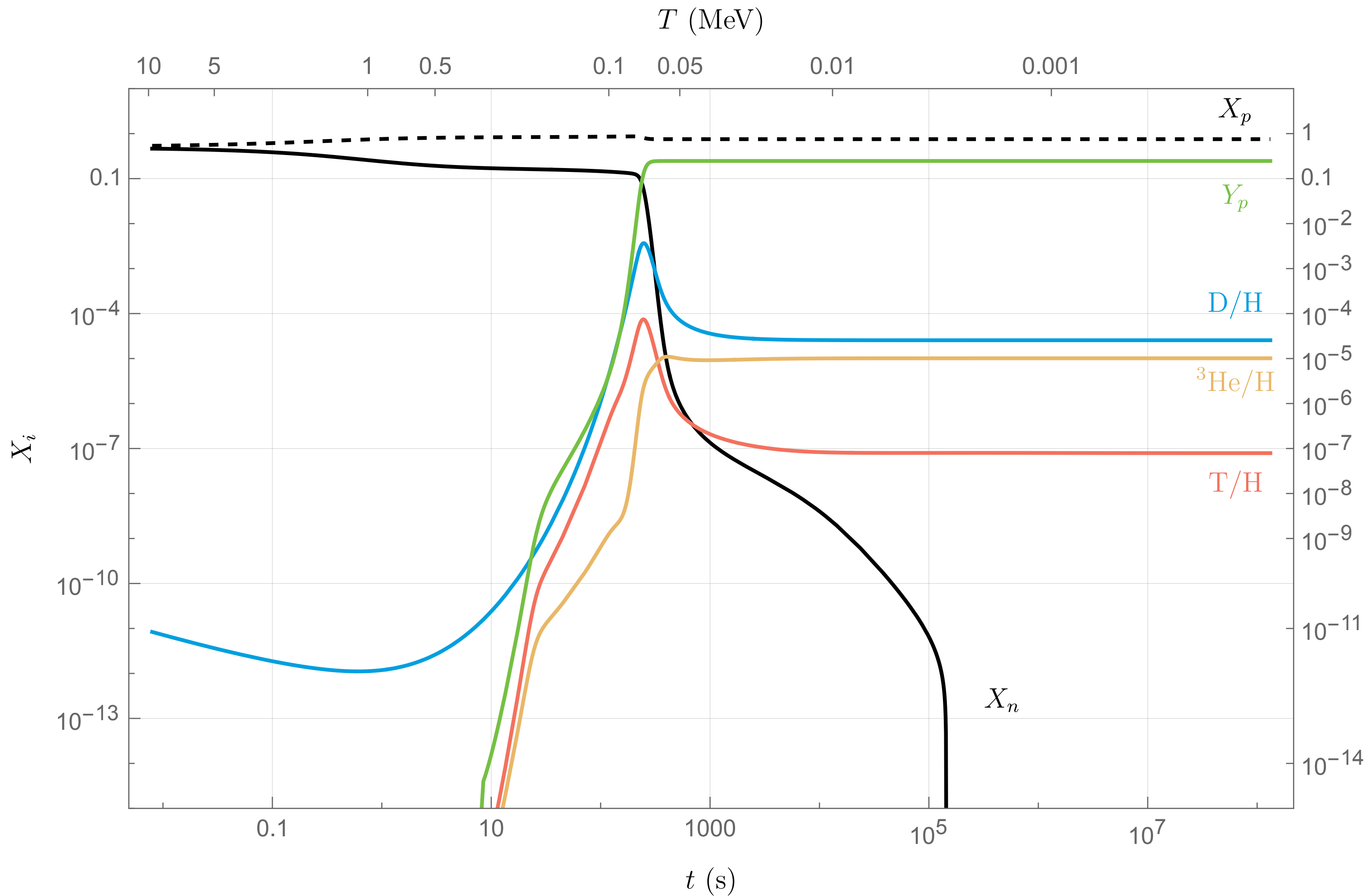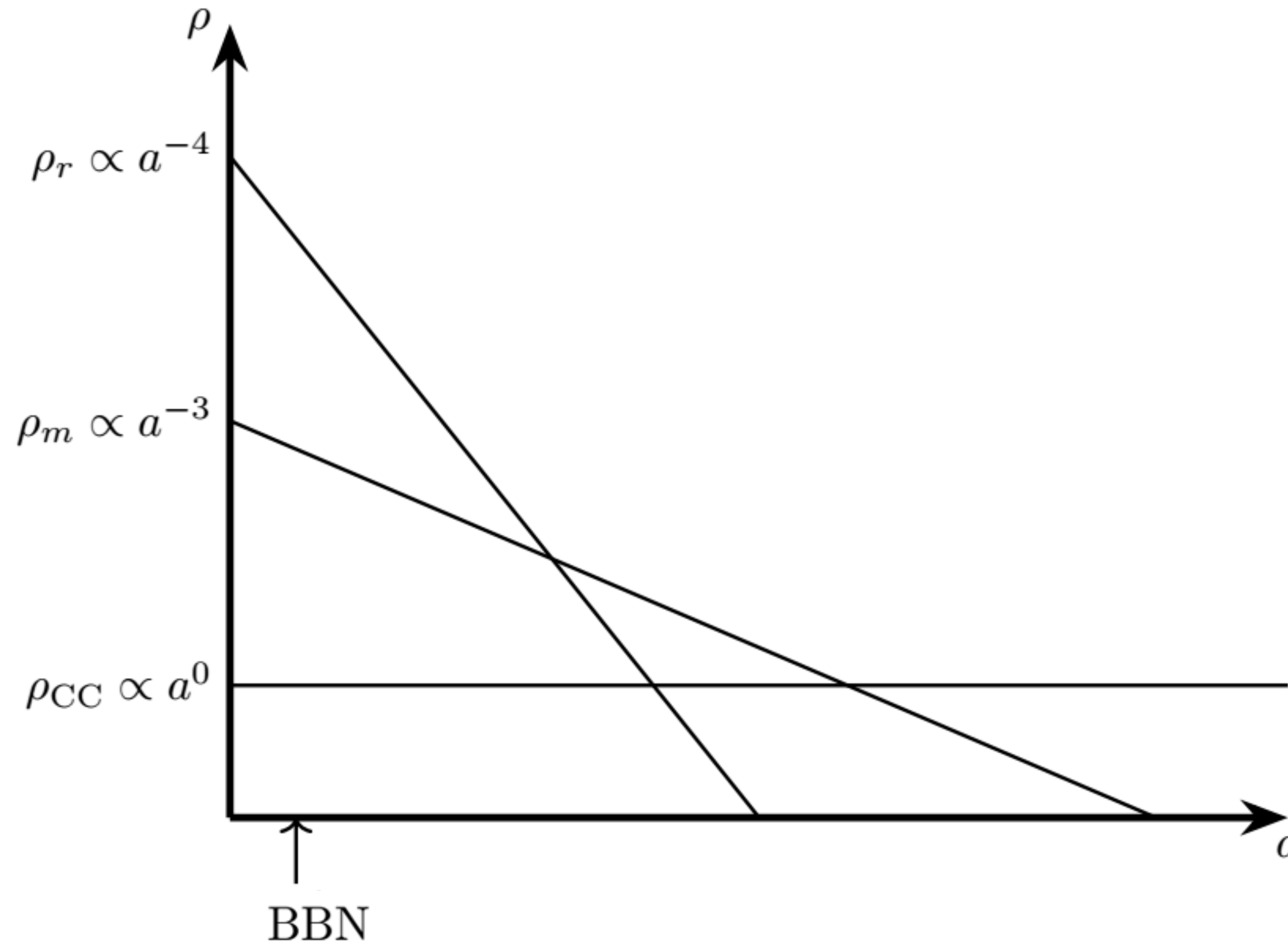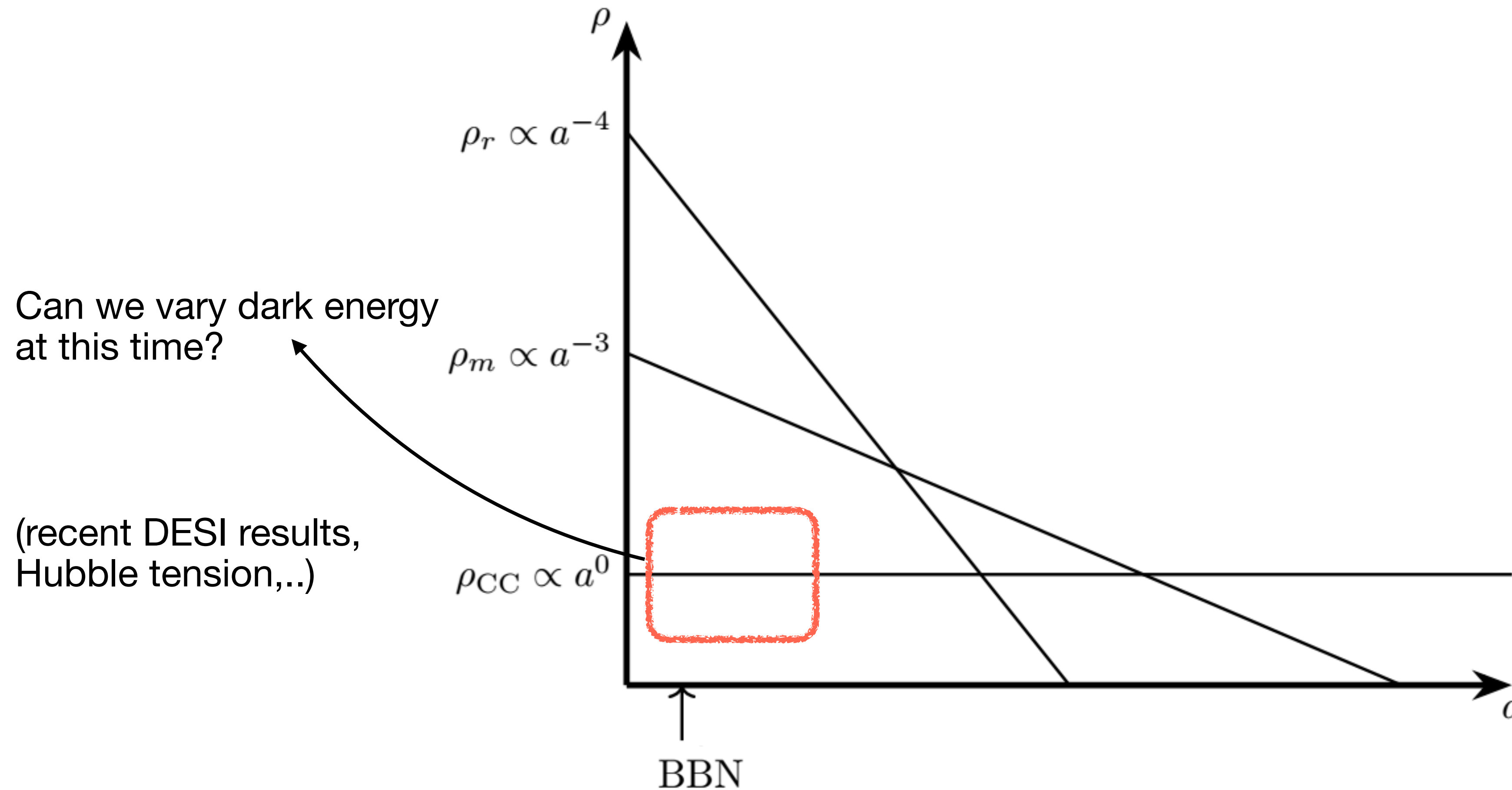
- The parameters of the theory are
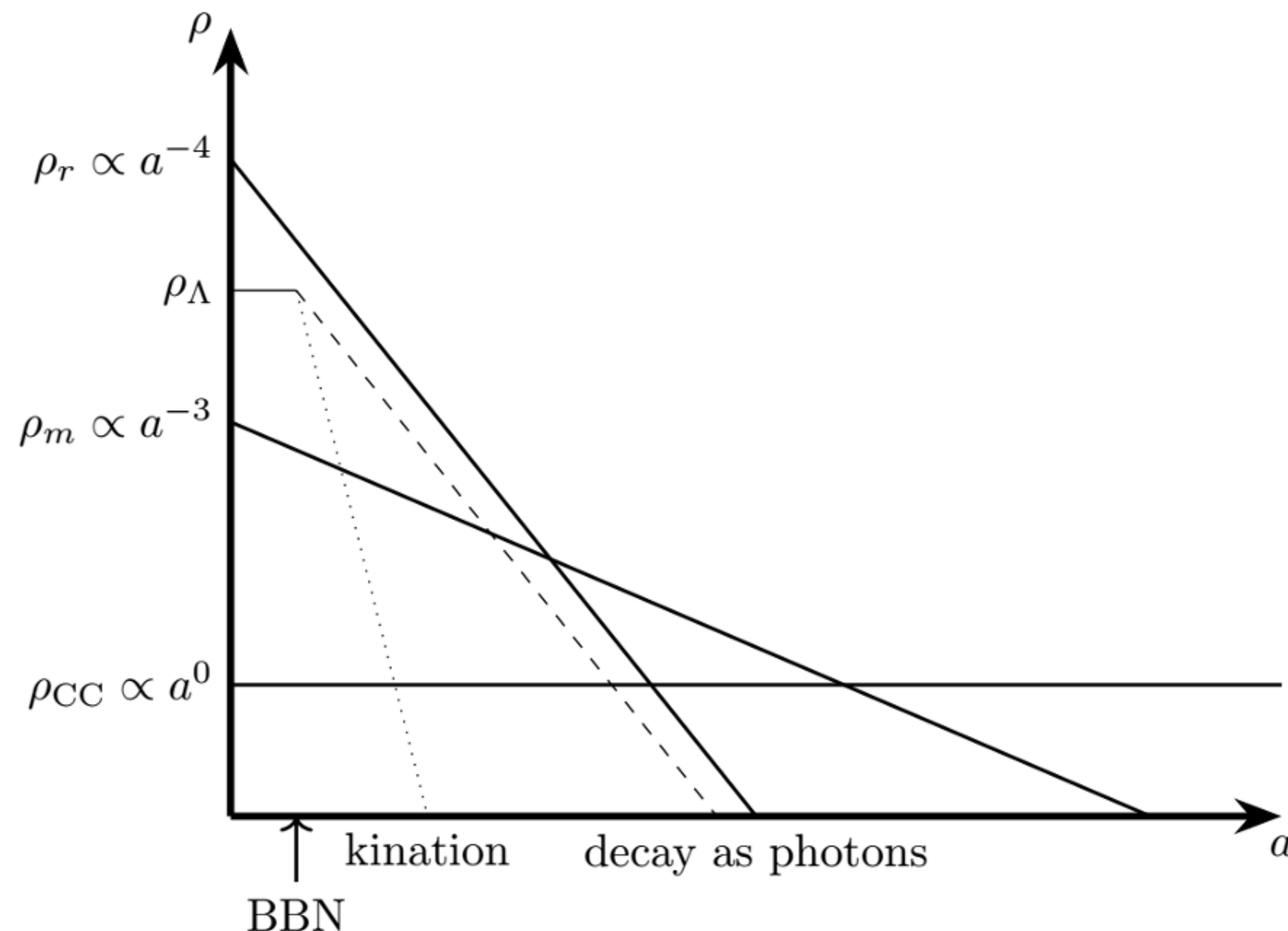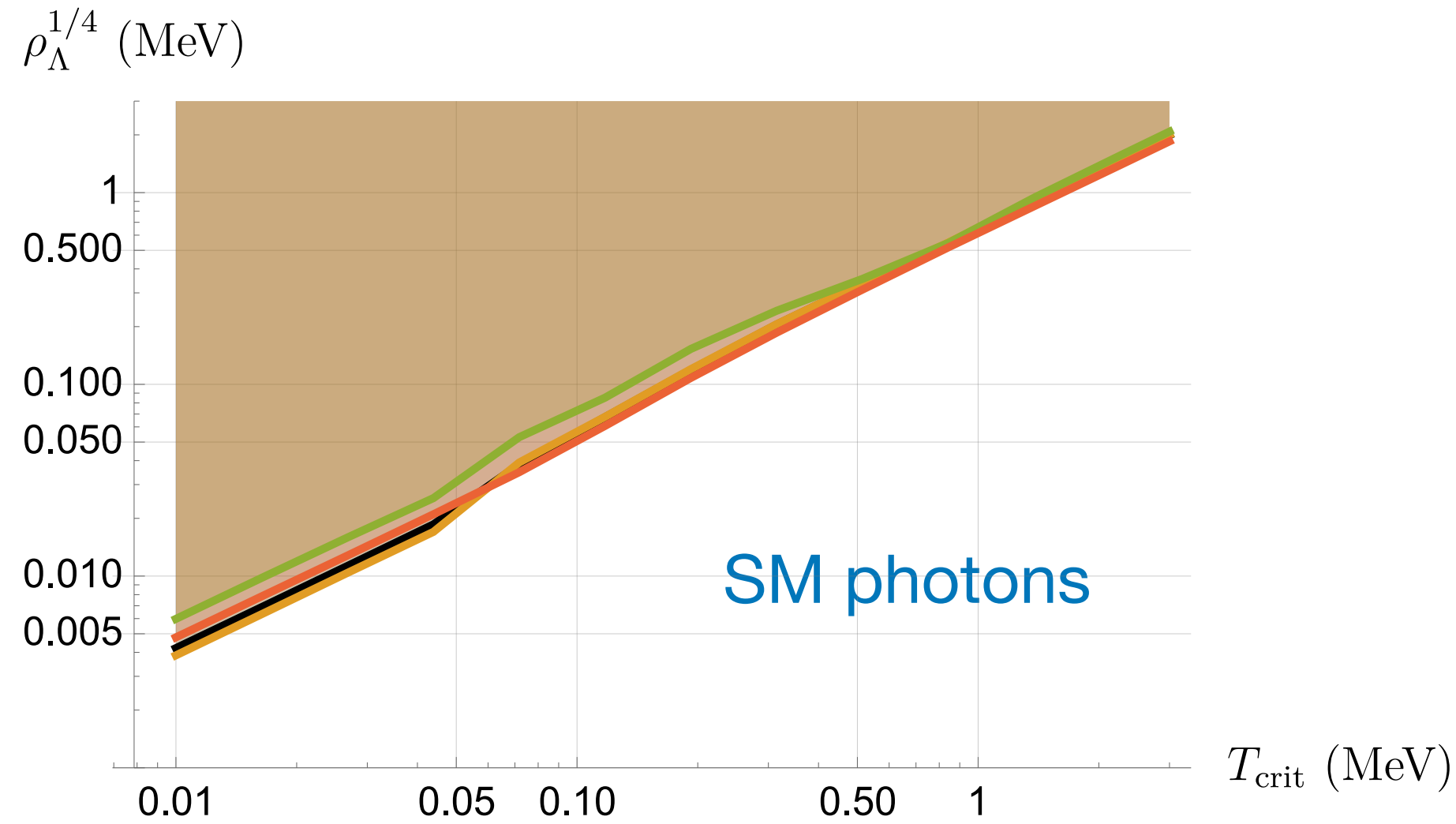
  - The initial amount of EDE ρ_Λ

  - The temperature when it starts decaying T_{crit}

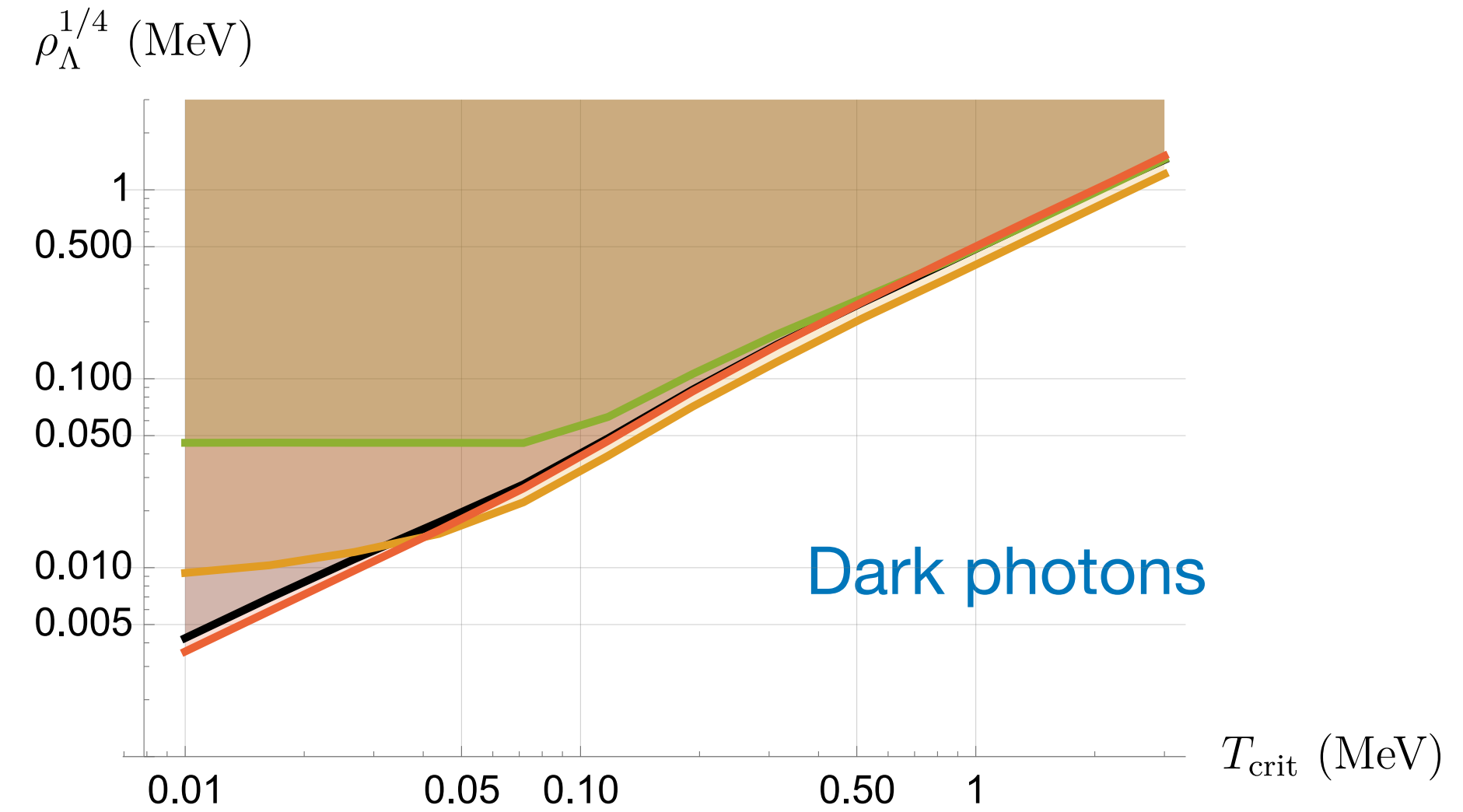 - The type of decay mode (photons, dark radiation, or kination).
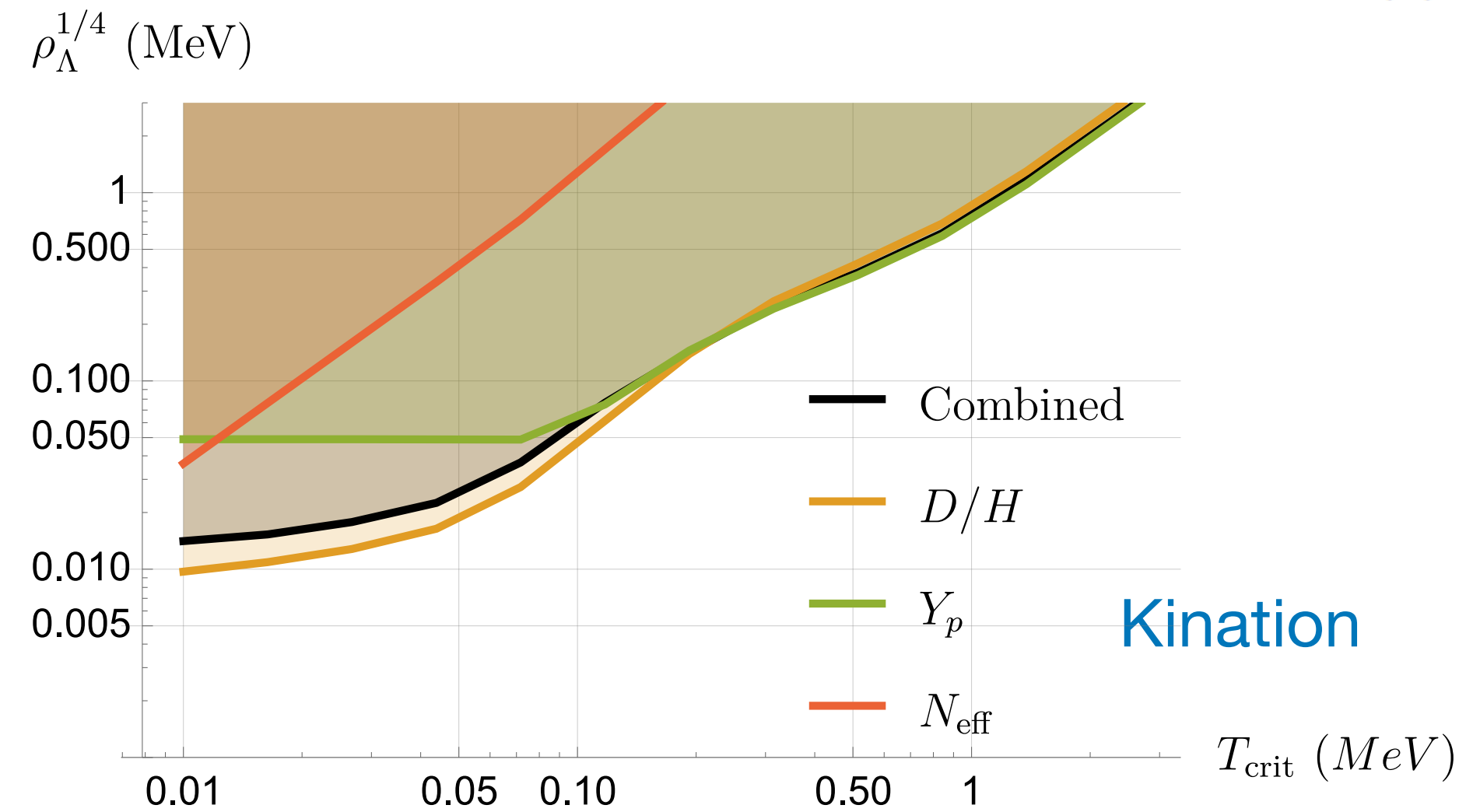
(a)

(b)

(c)

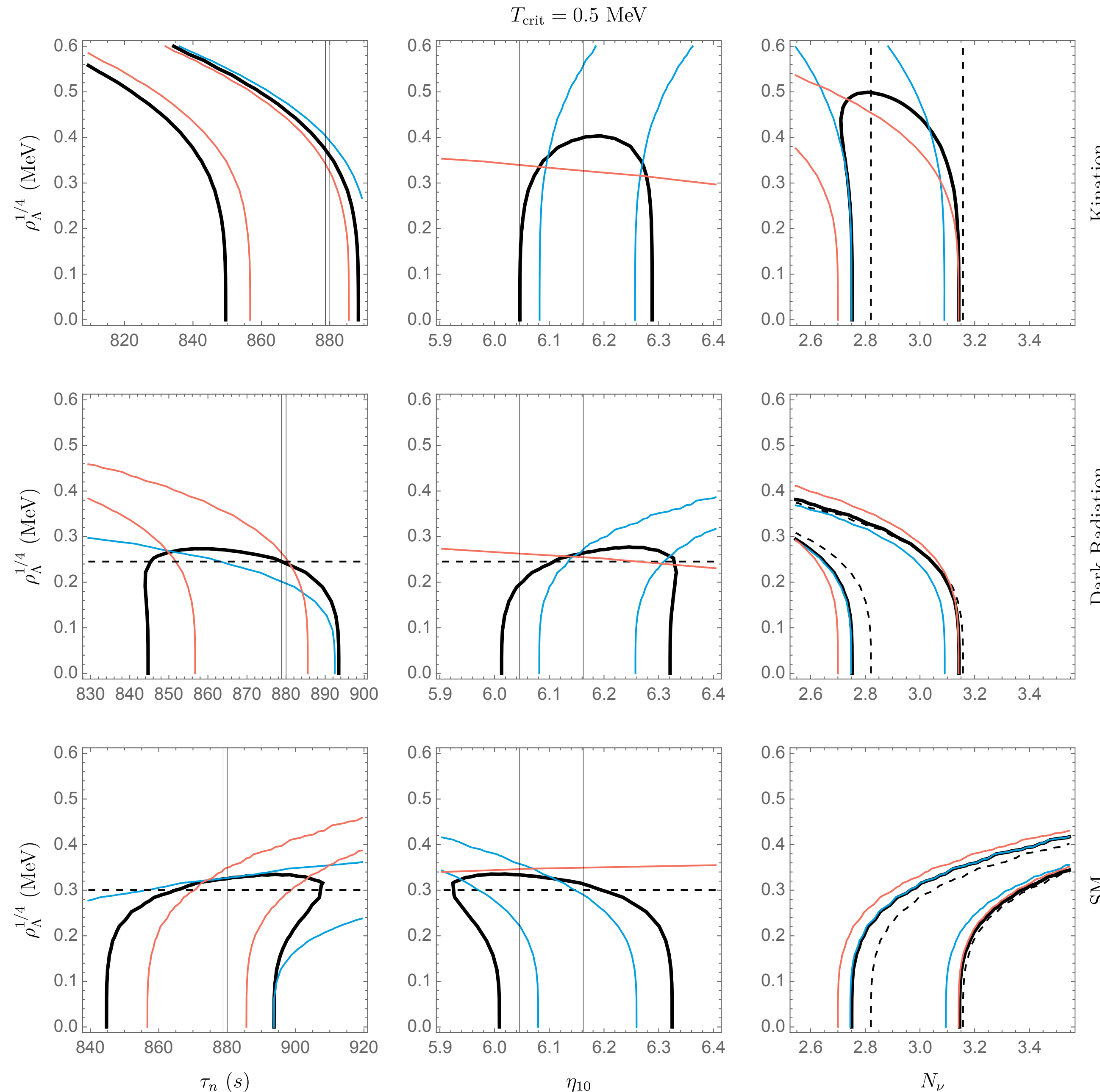[David McKeen, AO, in prep]

$T_{\rm crit} = 0.5$ MeV

$T_{\rm crit} = 0.5$ MeV

— D/H limits

— Y_p limits

······ $N_{\rm eff}$ limits

— Combined limit

[David McKeen, AO, in prep]
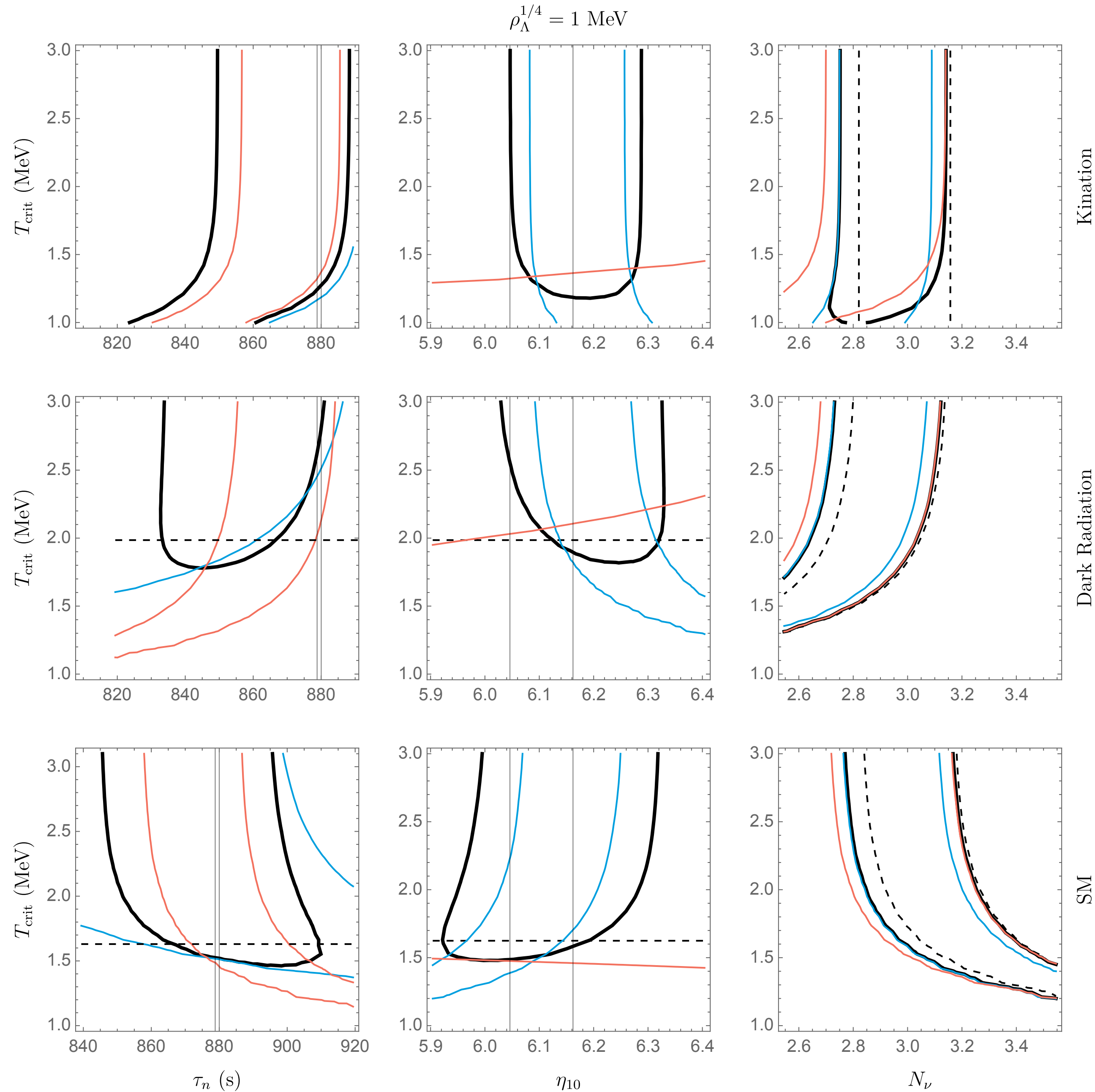
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Key Takeaways

- BBN is a good test of new physics as it's essentially parameter-free.

- Introducing an EDE component alters the expansion rate of the universe which in turns alters the outcomes of BBN.

- Altered BBN outcomes set limits on the input parameters of EDE, namely ρ_Λ and T_{crit}.

- Fixing one parameter, one could explore varying other typically-fixed BBN parameters (like τ_n, η_b, and N_ν).

Thank you for listening!

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Backup Slides

$$\rho_\Lambda^{1/4} = 1 \text{ MeV}$$

[David McKeen, AO, in prep]

13

$$\rho_\Lambda^{1/4} = 2 \text{ MeV}, \quad T_{\text{crit}} = 1 \text{ MeV}$$

SM

Kination

Dark photons

SM

ΛCDM

Kination

Dark photons