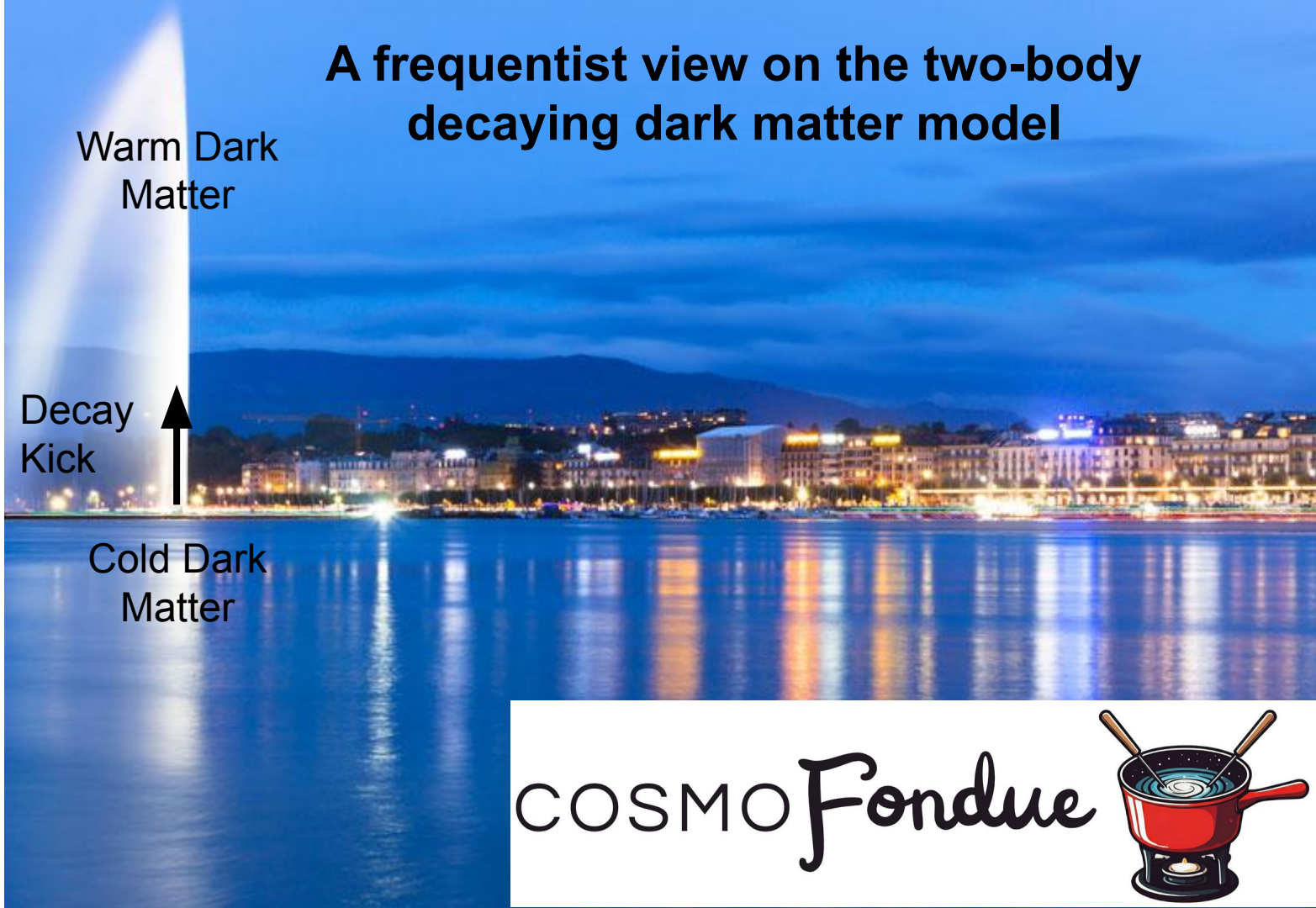
Thomas Montandon
Elsa M. Teixeira
Adele Poudou
Vivian Poulin

arXiv:2505.20193

A frequentist view on the two-body decaying dark matter model



COSMOFondue

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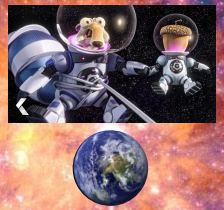
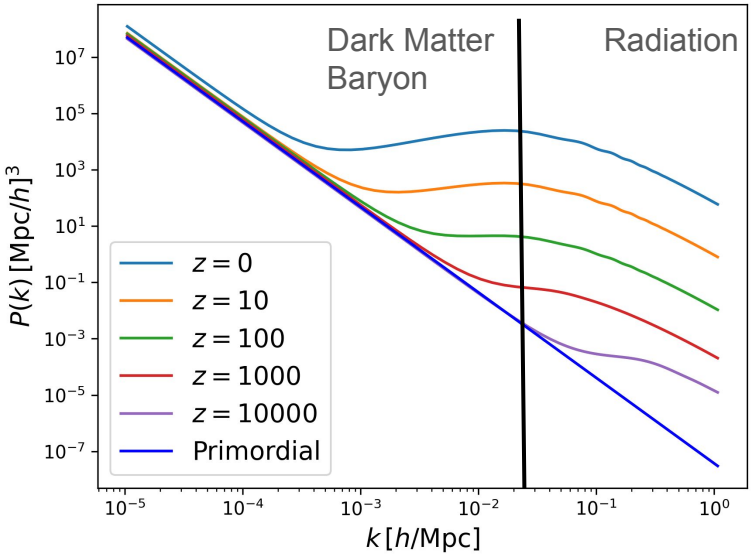
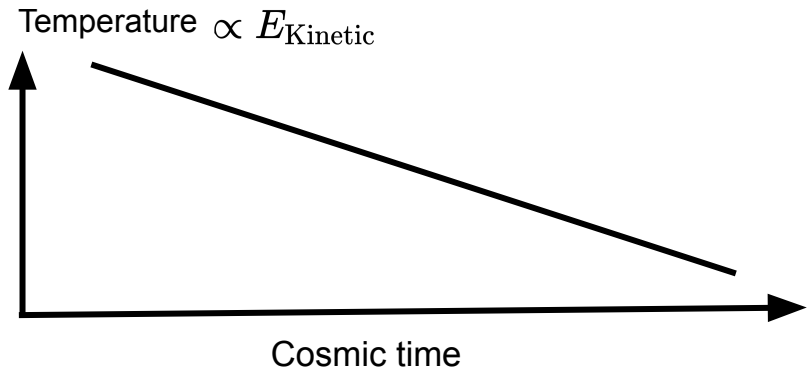


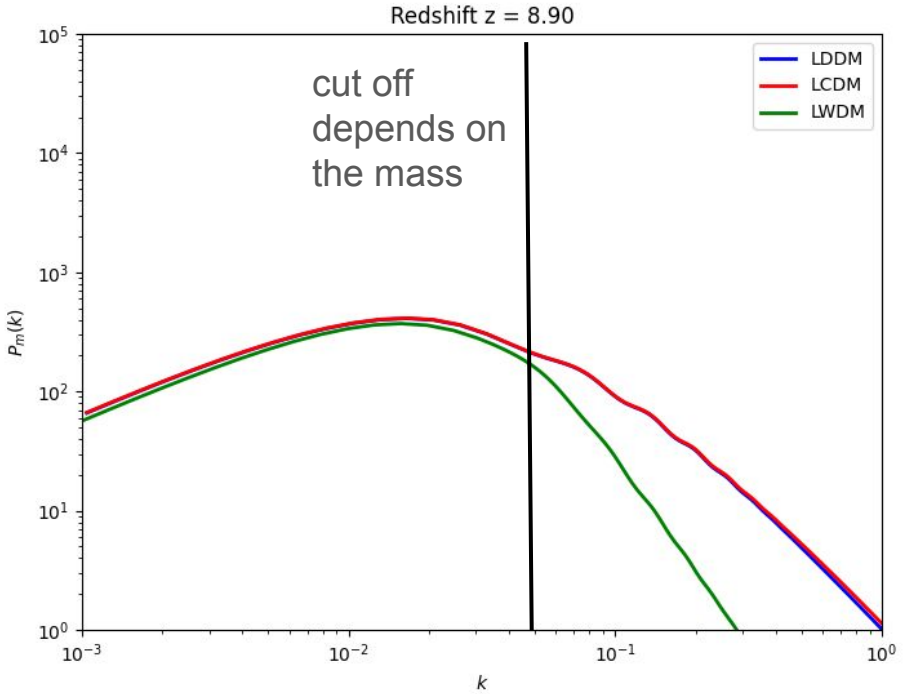
$$\langle \delta(\boldsymbol{k_1})\delta(\boldsymbol{k_2})\rangle = (2\pi)^3\delta(\boldsymbol{k_1}+\boldsymbol{k_2})P(k_1)$$



Decaying Dark Matter

- What?
  - cold: $E_{\text{kinetic}} \ll m$
  - hot: $E_{\text{kinetic}} \gg m$
  - warm:





$E_{\text{kinetic}} \gg m \longrightarrow E_{\text{kinetic}} \sim m \longrightarrow E_{\text{kinetic}} \ll m$

Like Neutrinos!

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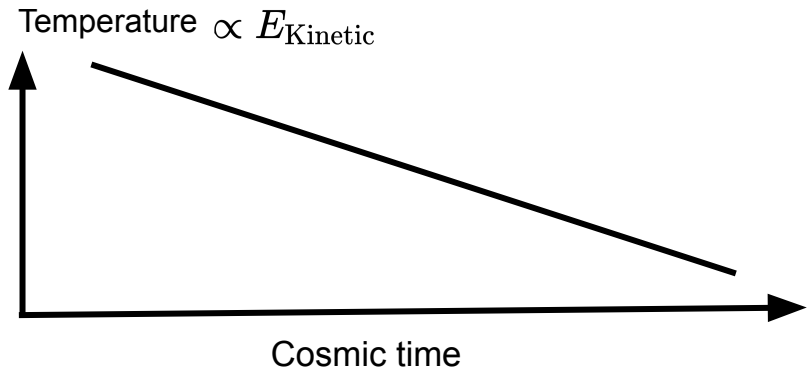

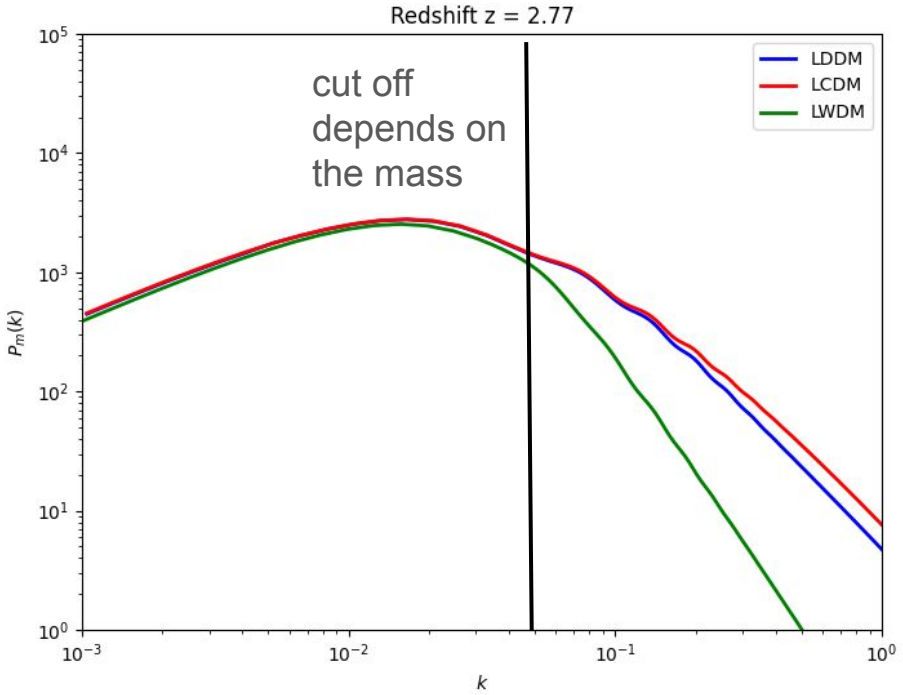

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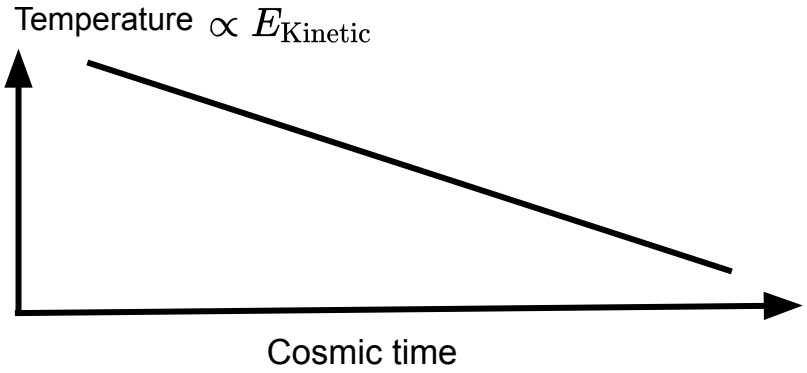

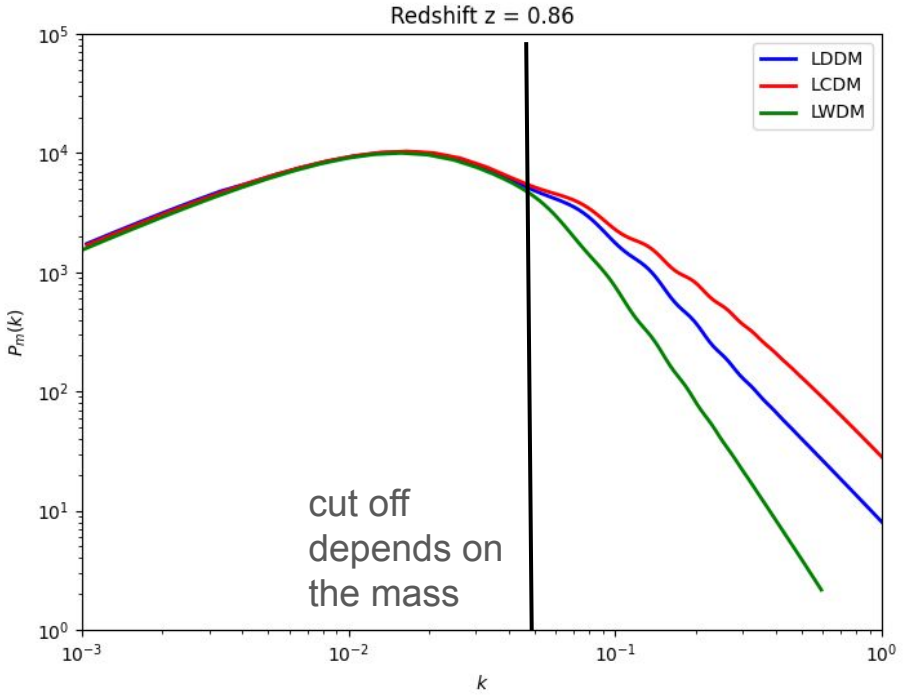

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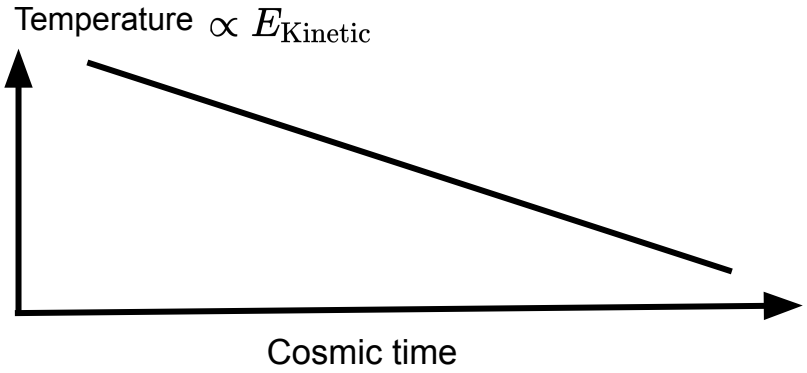

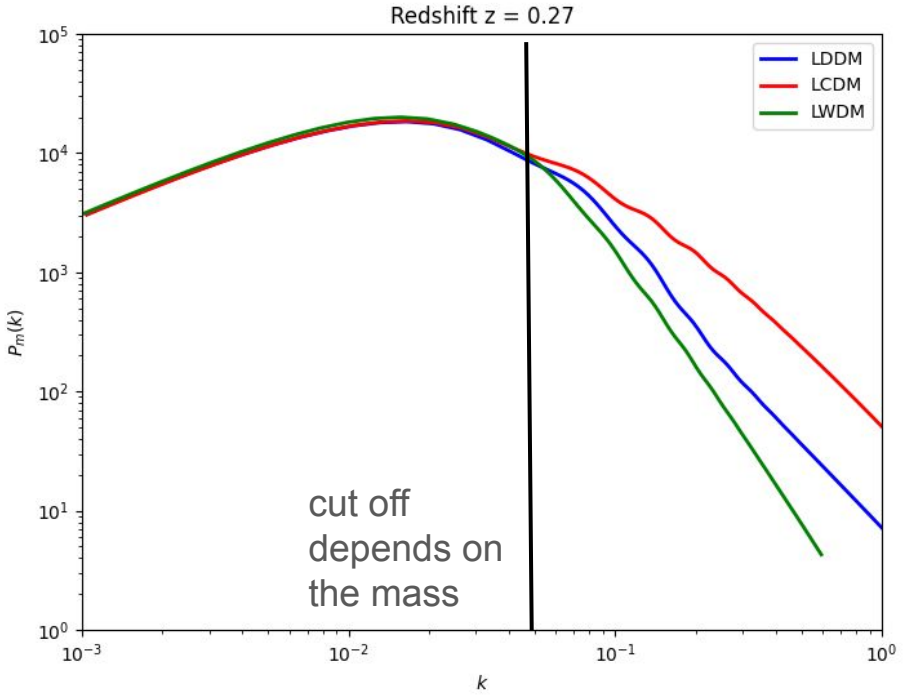

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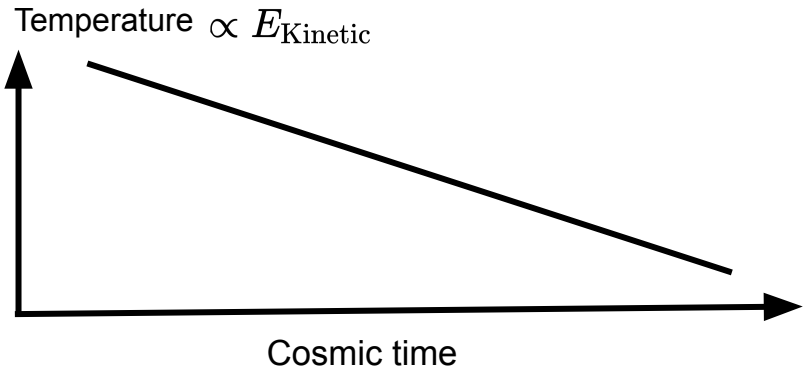

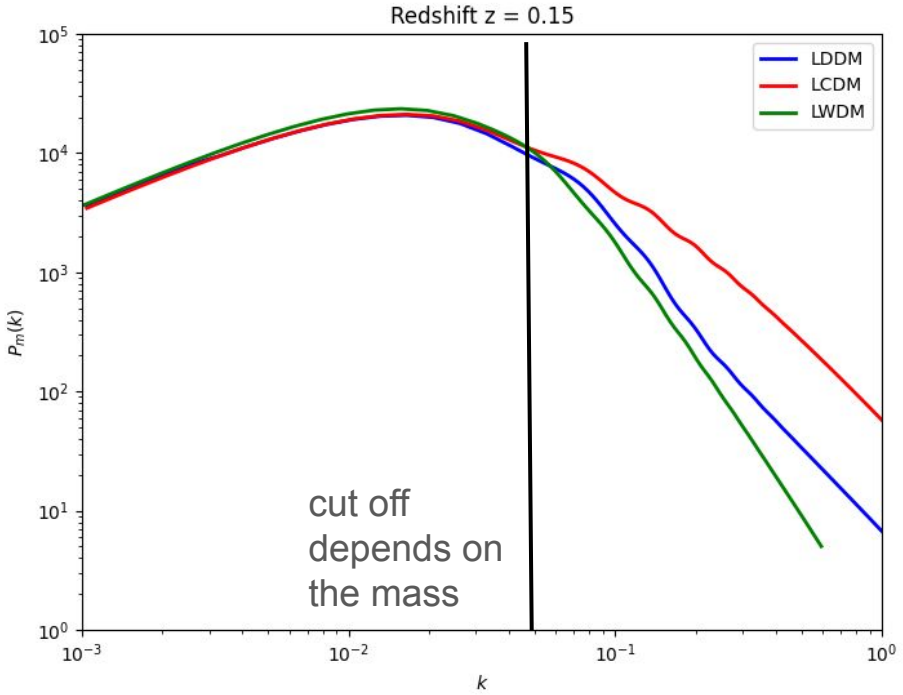

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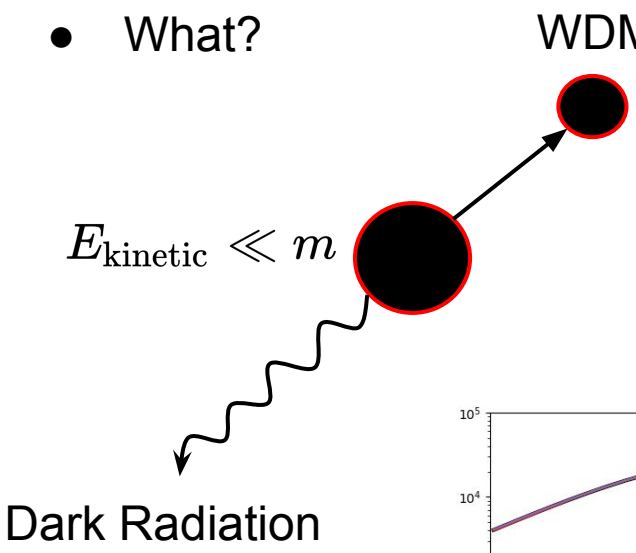
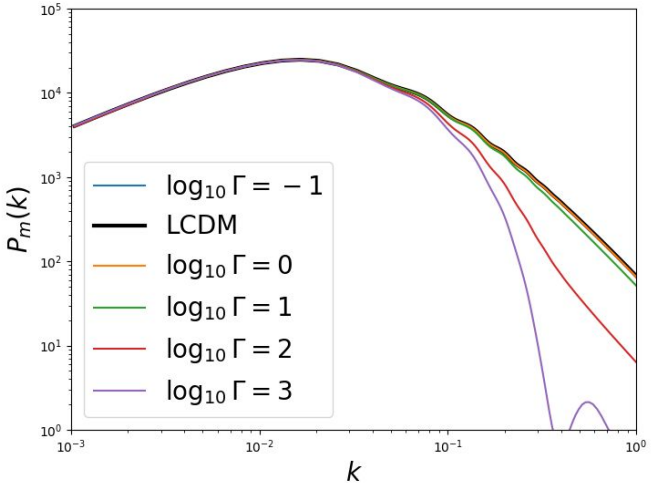
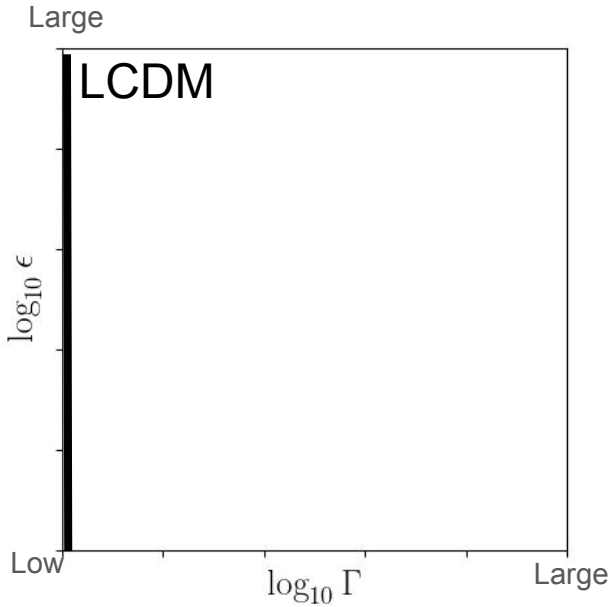


Two parameters:

- Life time Γ^{-1}
- kick $\varepsilon = \frac{1}{2}\left(1 - \frac{m_{\text{wdm}}}{m_{\text{cdm}}}\right)$





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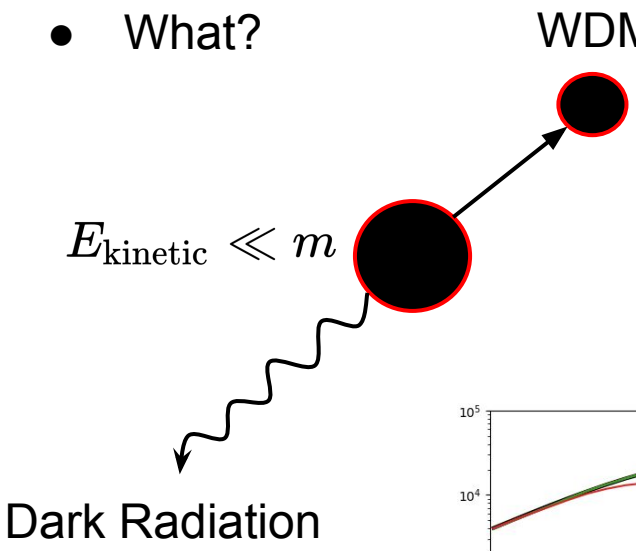

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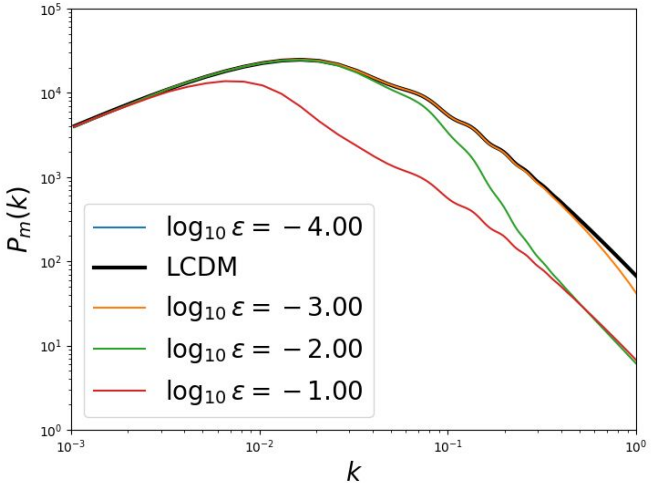

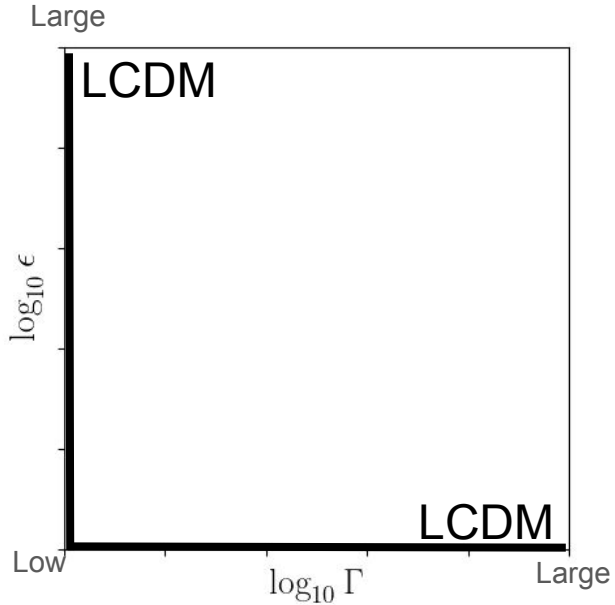

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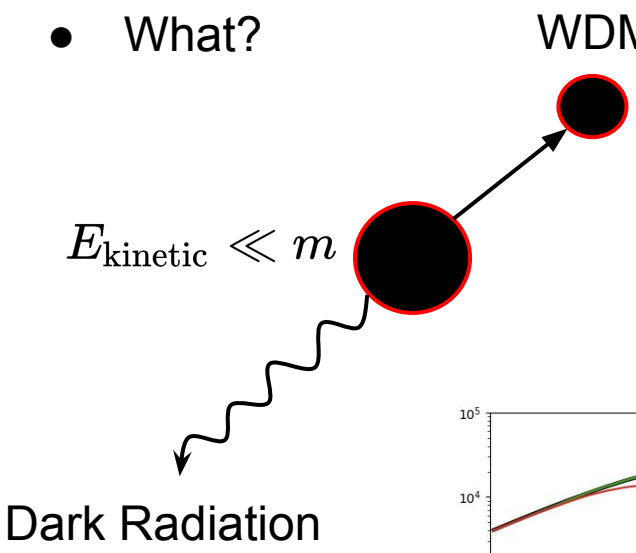

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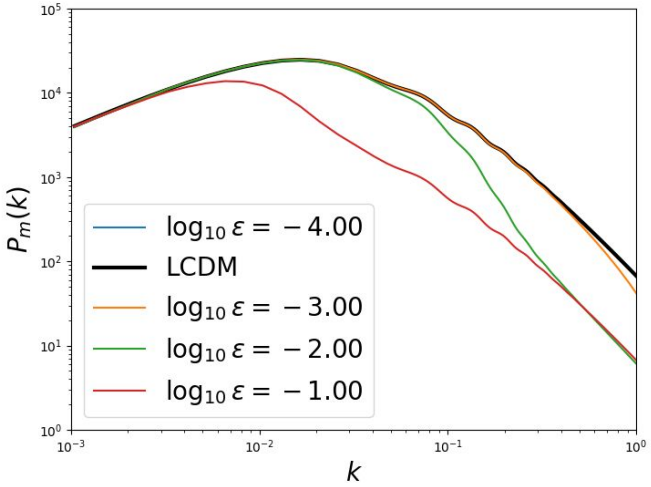
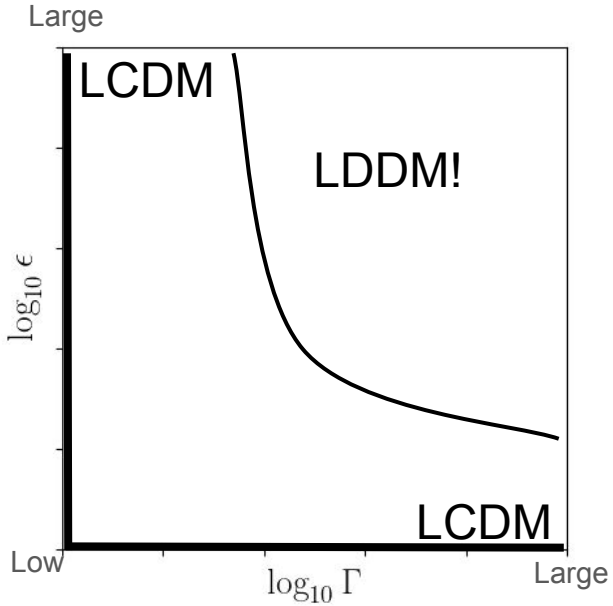


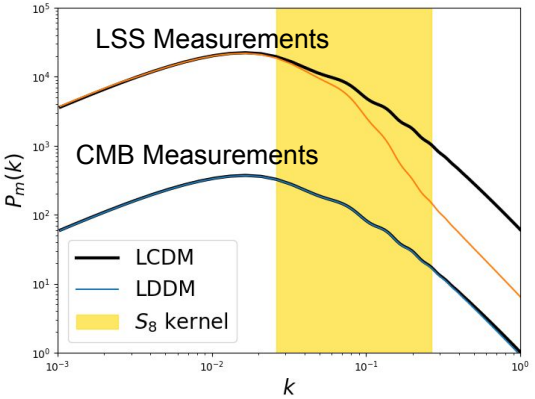


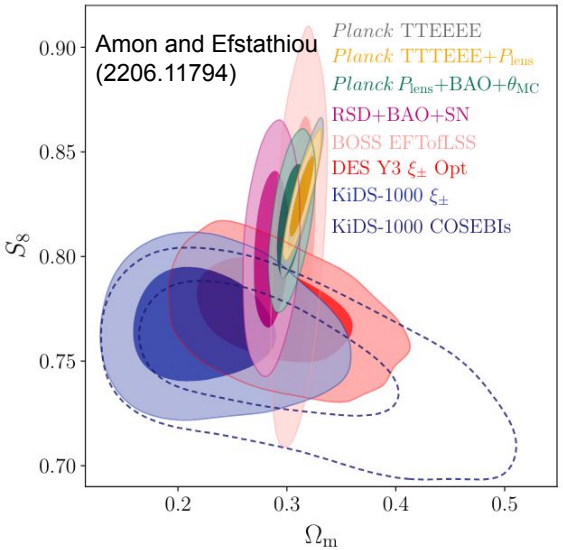
Sigma-8 tension

- Why?

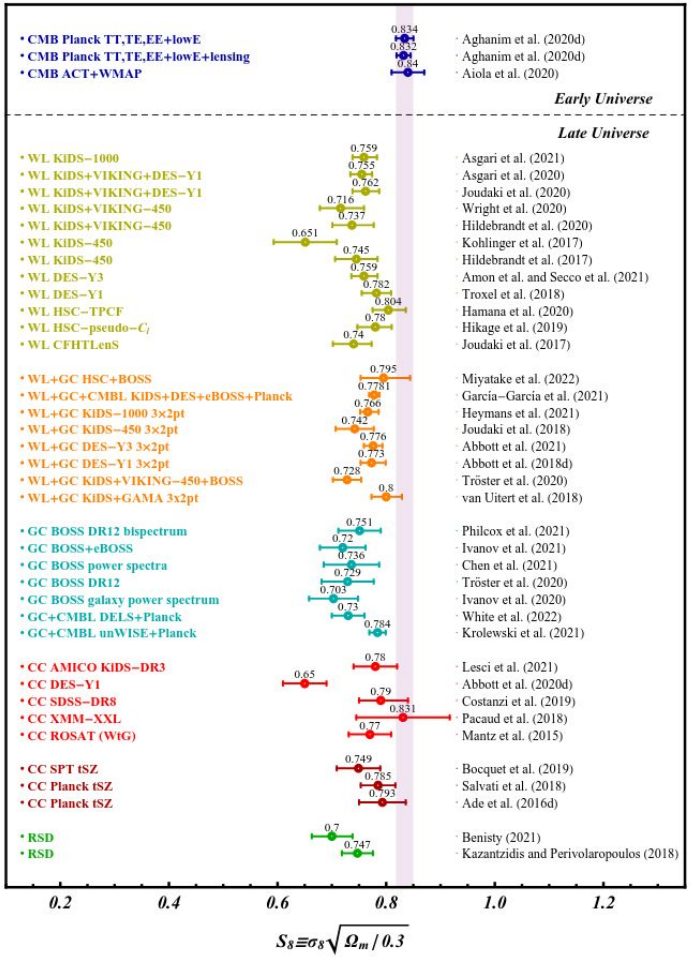
$$\sigma_R^2 = \int dk \frac{k^2 P_m(k)}{2\pi^2} W^2(kR)$$

$$R = 8h^{-1}\mathrm{Mpc} \sim \text{Galaxy clustering scale}$$





Abdalla et al (2203.06142)



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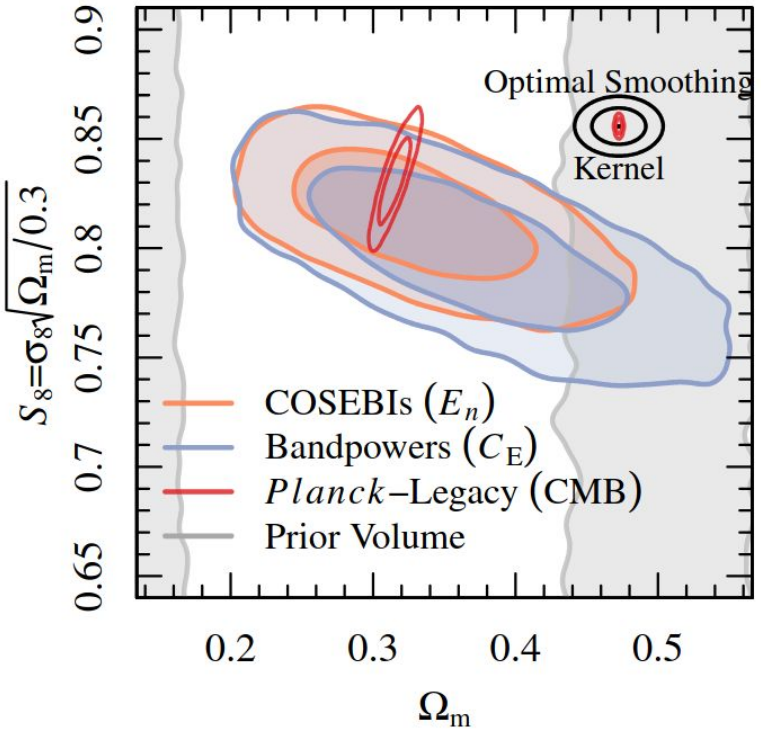
The KiDS Collaboration: 2503.19441



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We can still test nature of DM!

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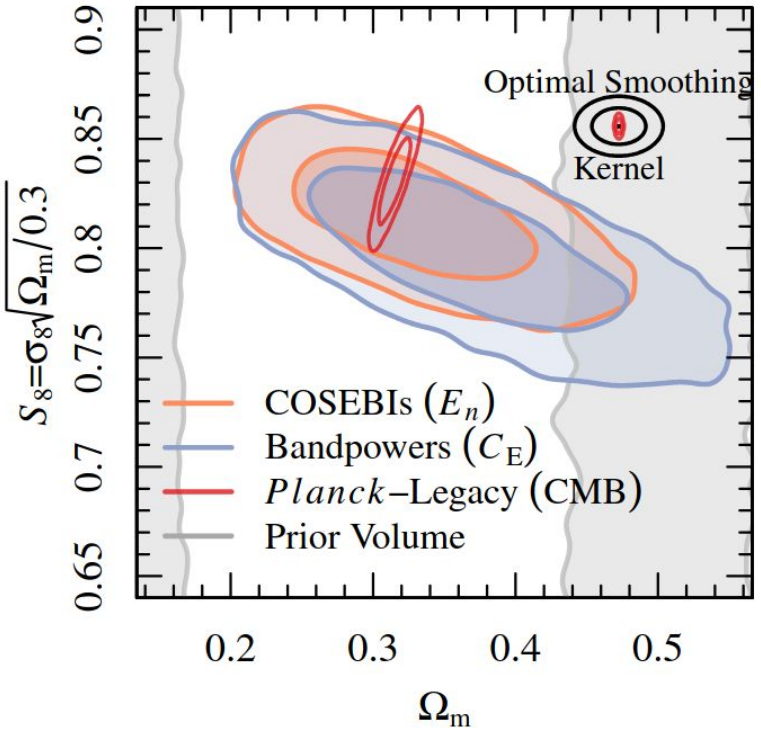
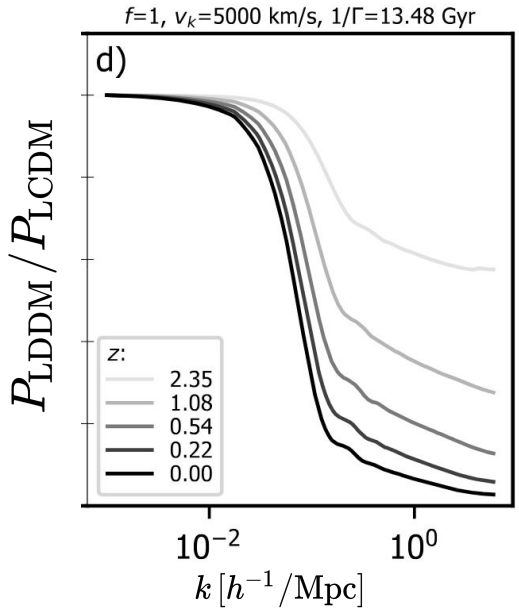
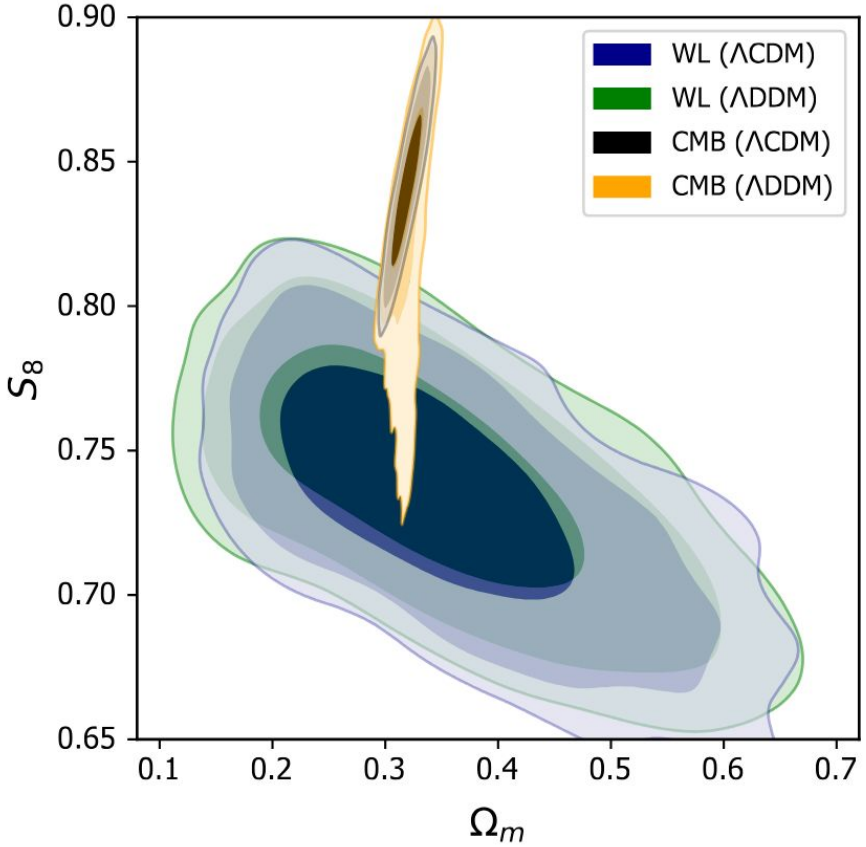


Decaying Dark Matter
Bayesian analysis

- How?
- For LSS we need Non Linearity!
  J.Bucko, A.Schneider et al. 2307.03222
  - DDM simulation with PKDGRAV3
  - Neural Network fit of P(k)





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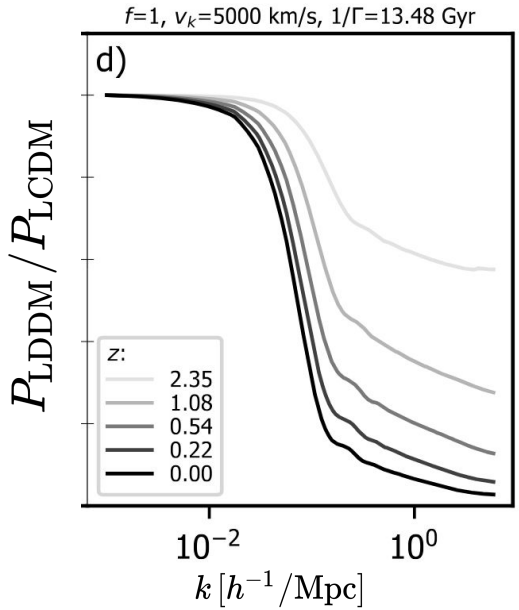
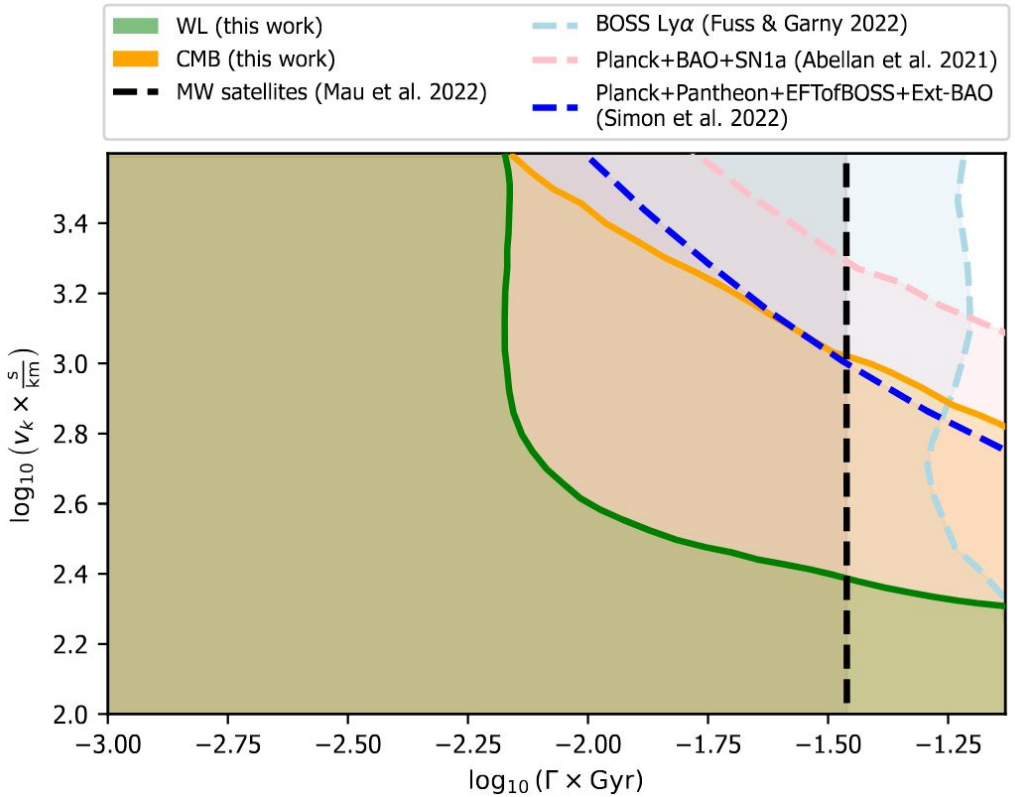
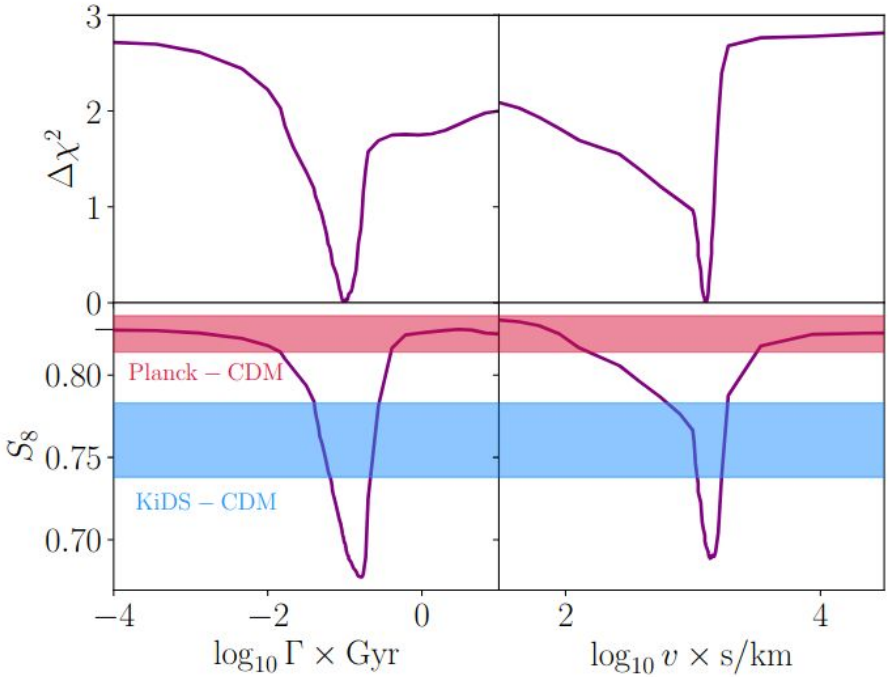


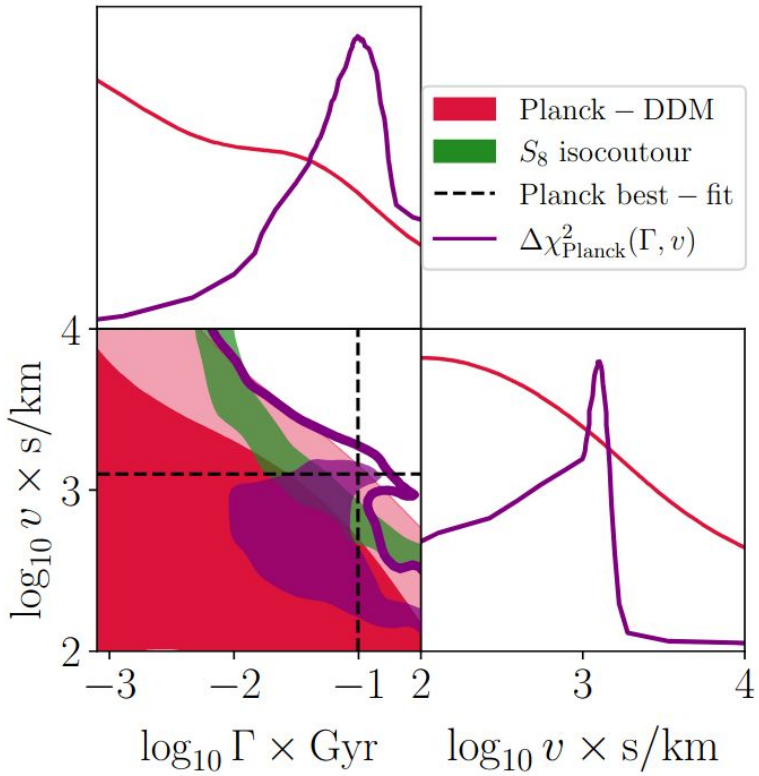


$$\Gamma = 0.10^{+0.17}_{-0.05}\,\mathrm{Gyr}^{-1}\,,$$
$$t_{1/2}^{\mathrm{DDM}} = 6.93^{+7.88}_{-2.85}\,\mathrm{Gyr}\,,$$
$$N_0^{\mathrm{DDM}}/N_{\mathrm{ini}} = 0.25^{+0.27}_{-0.16}\,,$$
$$v = 1250^{+1450}_{-1000}\,\mathrm{km/s}\,,$$

Our work:

- Planck: There is something here!





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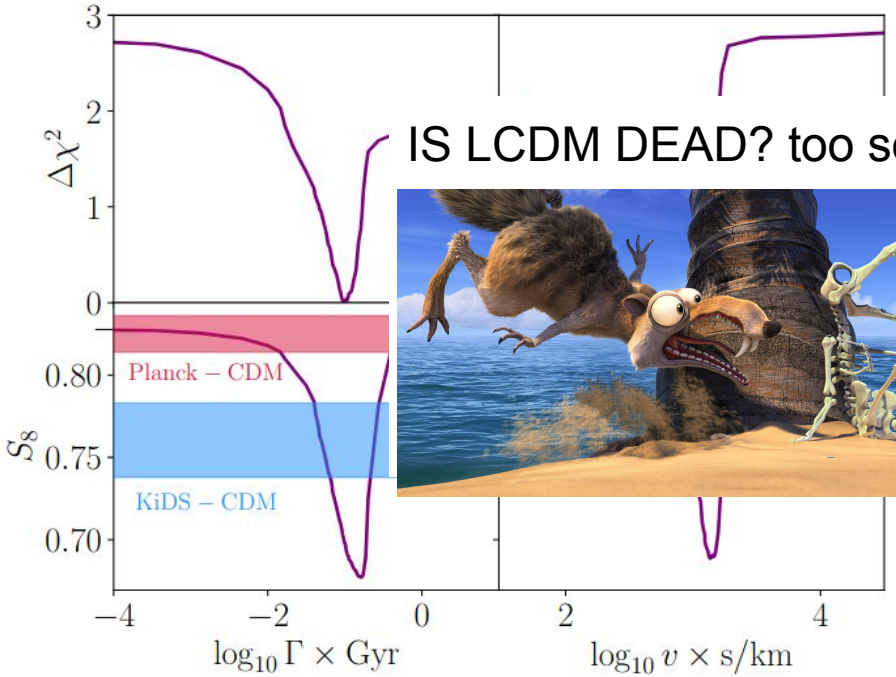
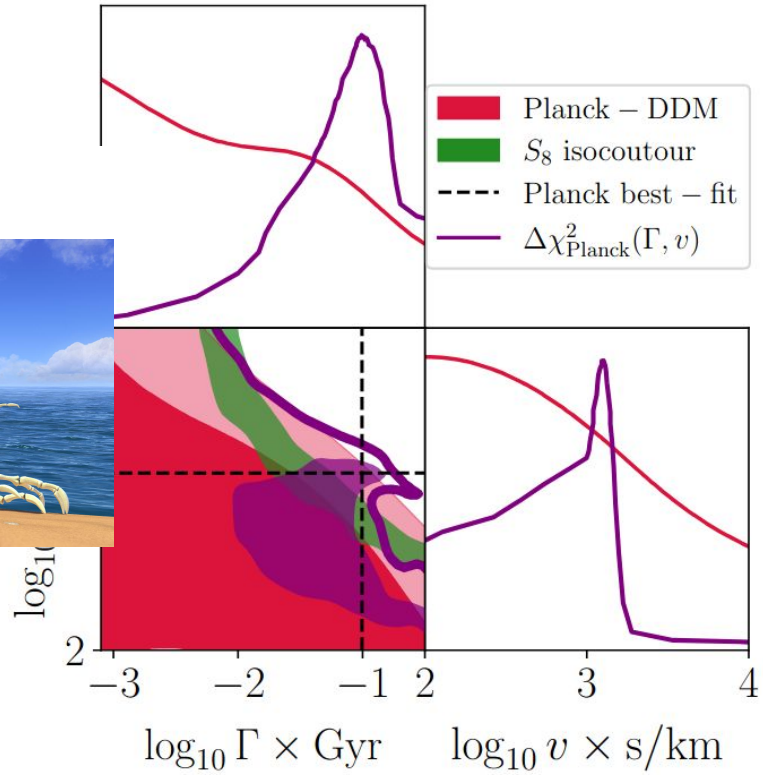
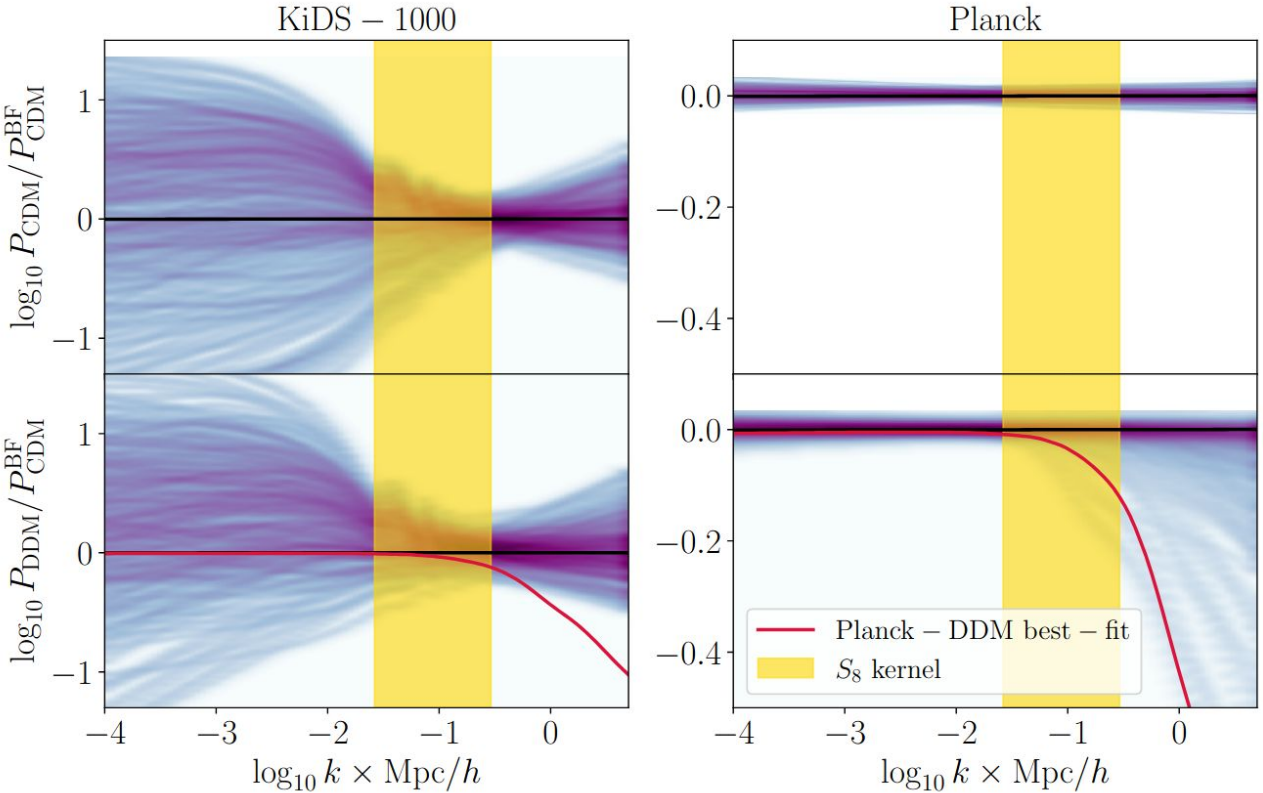


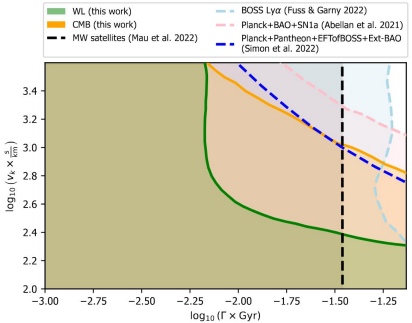
IS LCDM DEAD? too soon



Our work:

- Planck: There is something here!
- What KiDS really measures: not just S8!





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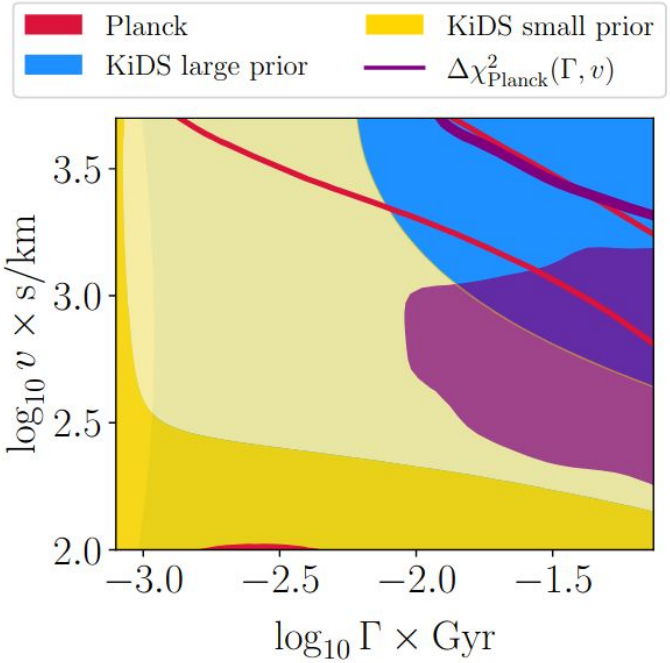

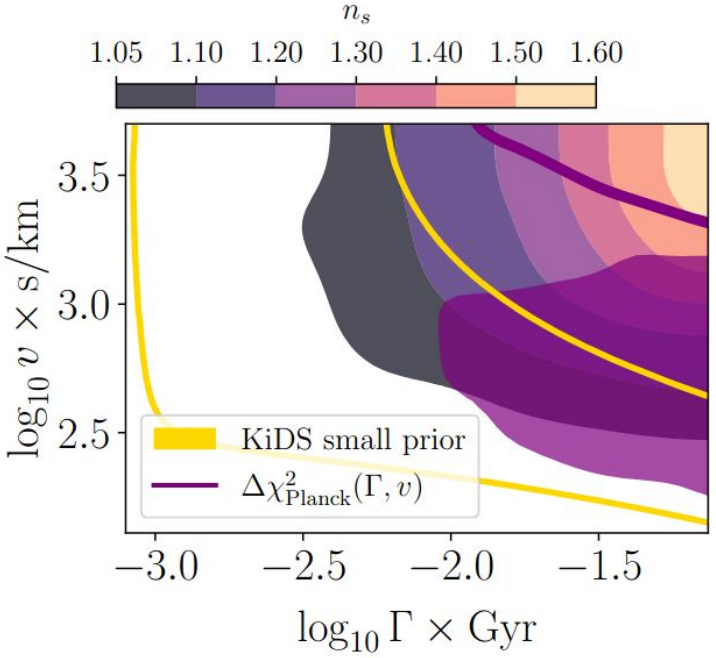

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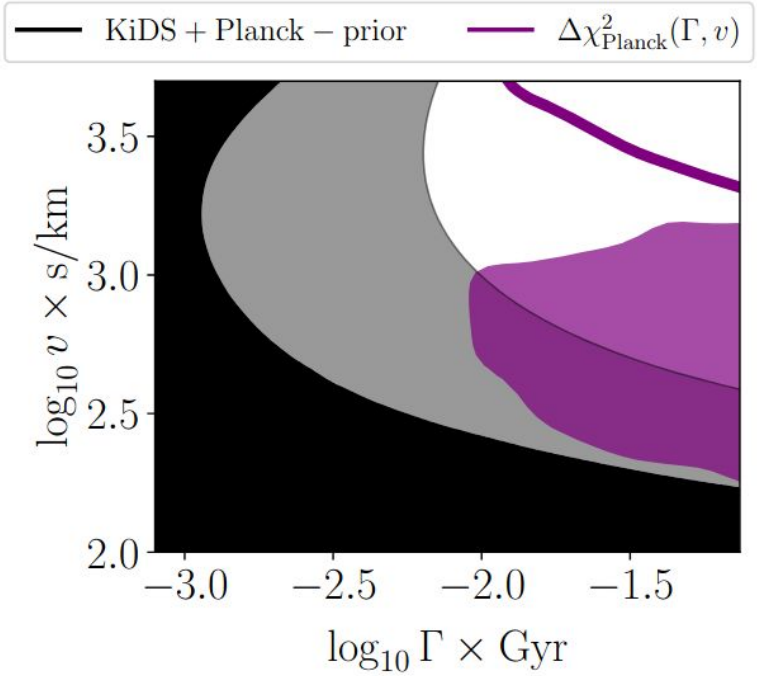
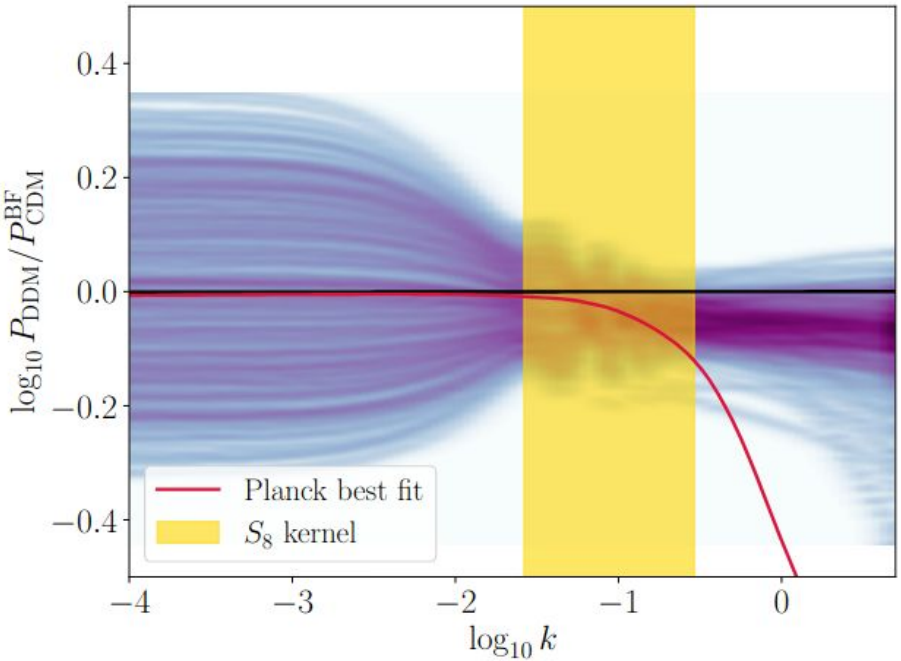
- KiDS and Planck





Conclusion

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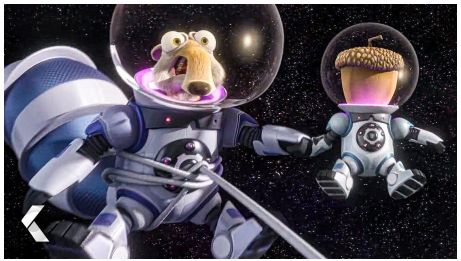
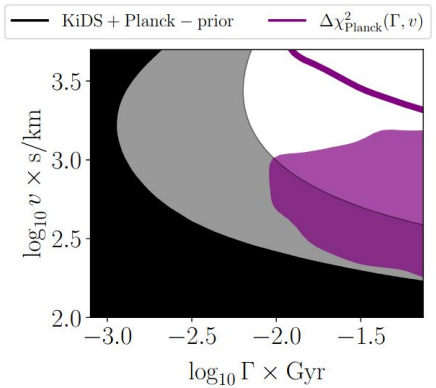
$$v = 1250^{+1450}_{-1000}\,\mathrm{km/s}\,,$$

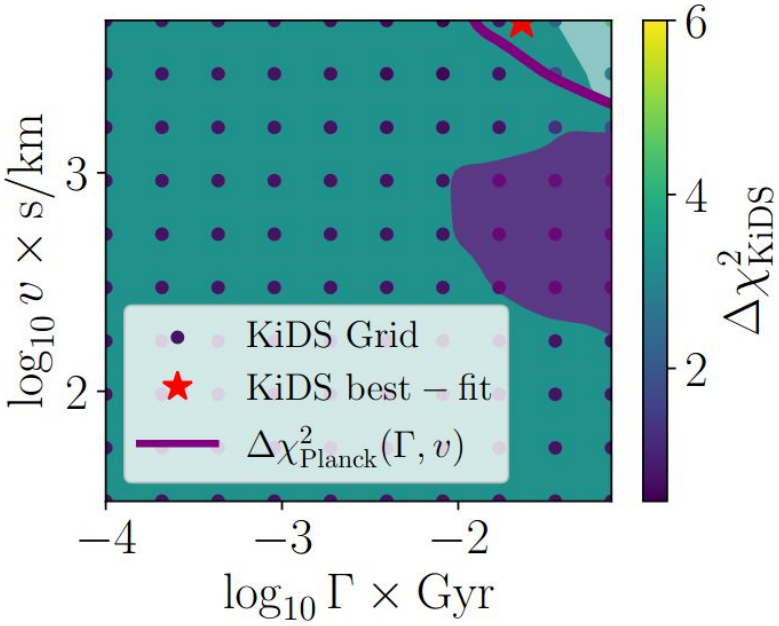
- Planck-2018 + BOSS-BAO + Pantheon-Plus
  - Subject to volume effect
  - Best-fit S8 compatible with KiDS
- KiDS-1000
  - Cannot be reduced to its S8 measure (eg S8-prior)
  - Subject to prior effect
- KiDS + Planck-informed prior





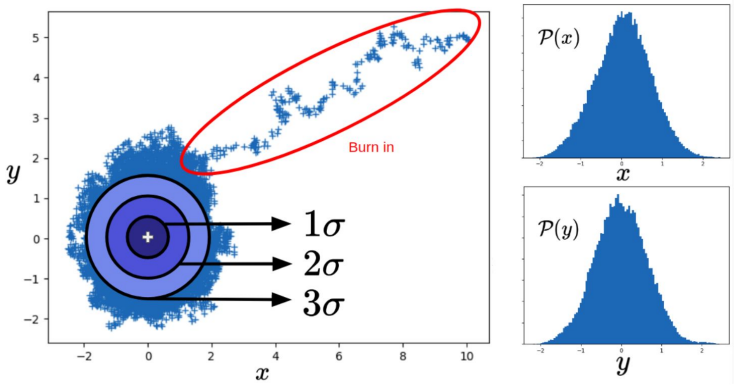
Our work:

- KiDS profile likelihood



Bayesian vs Frequentist

Bayesian: density of points



Profile likelihood:
prior independent!

A.Nygaard et al 2308.06379