

Constraining Dark Matter with Future Surveys

Aurel Schneider – University of Zurich

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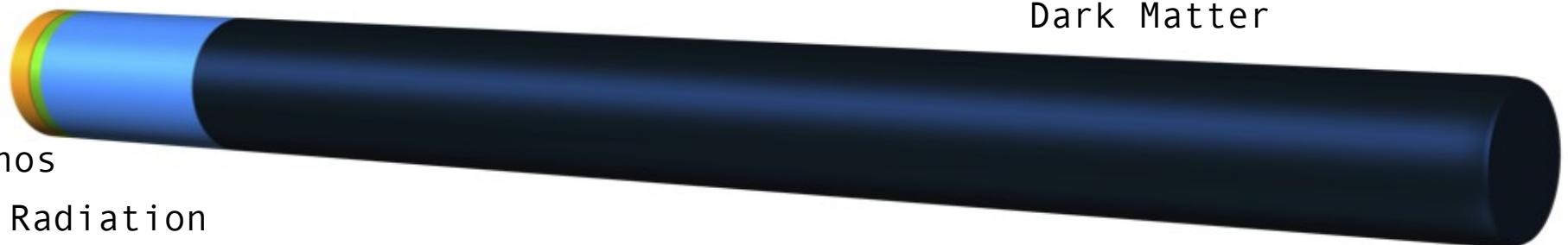
Intro to Dark Matter

Stars/Planets Gas (H, He)

Dark Matter

Neutrinos

Radiation



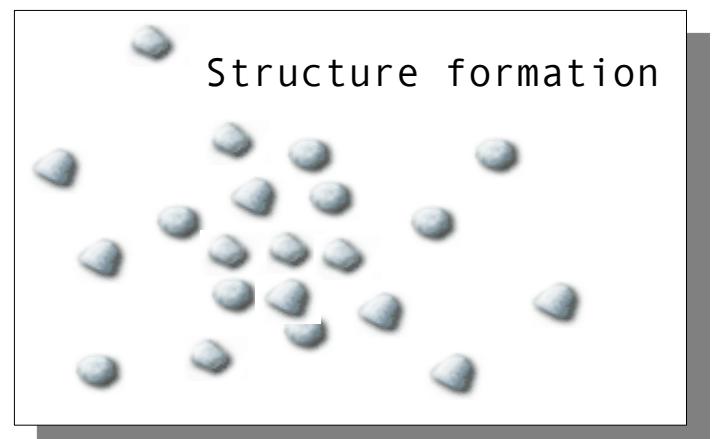
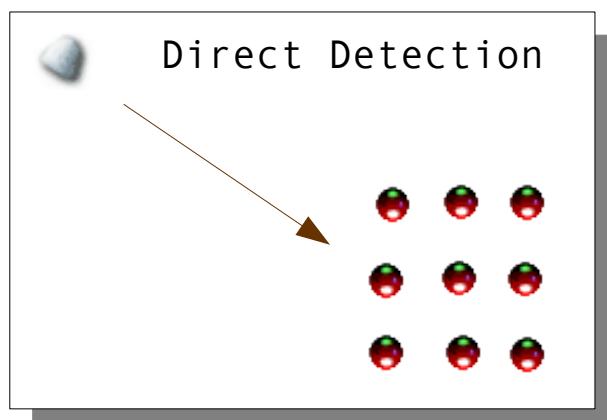
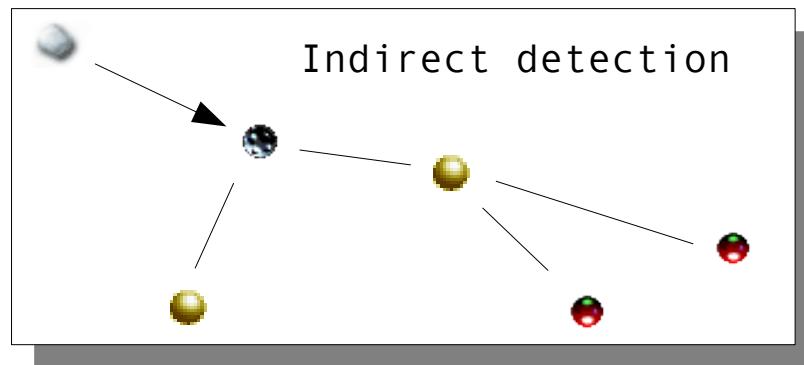
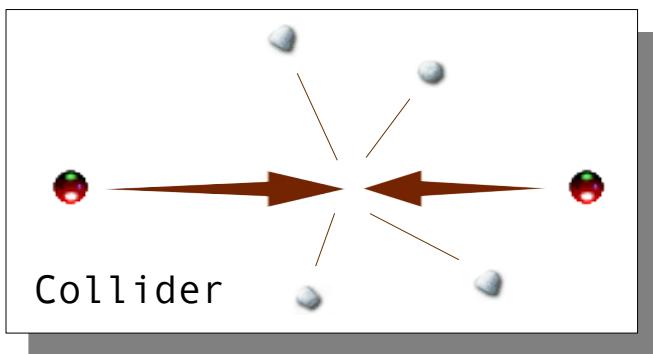
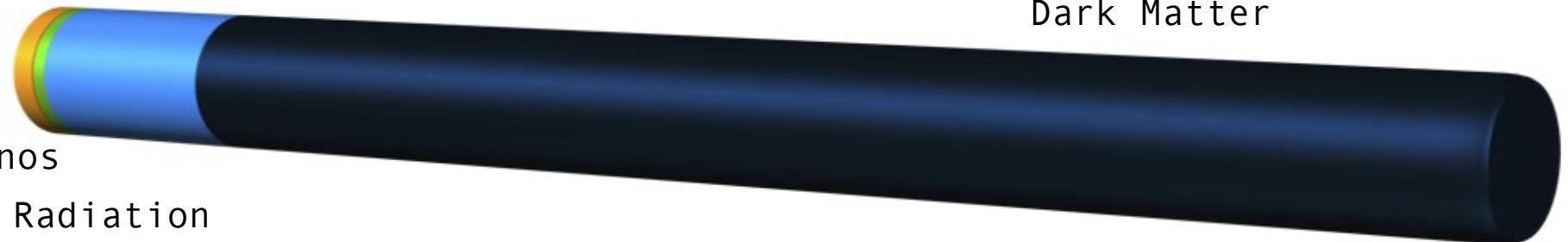
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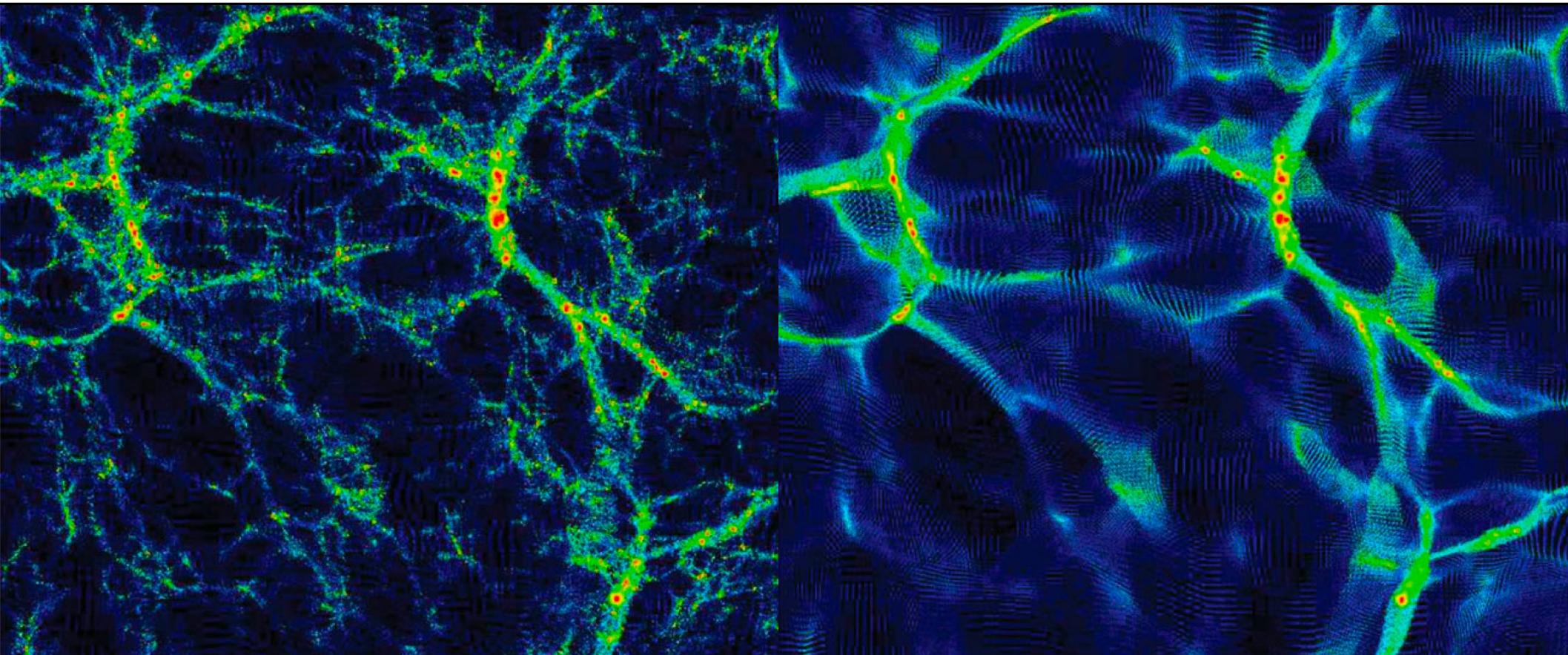
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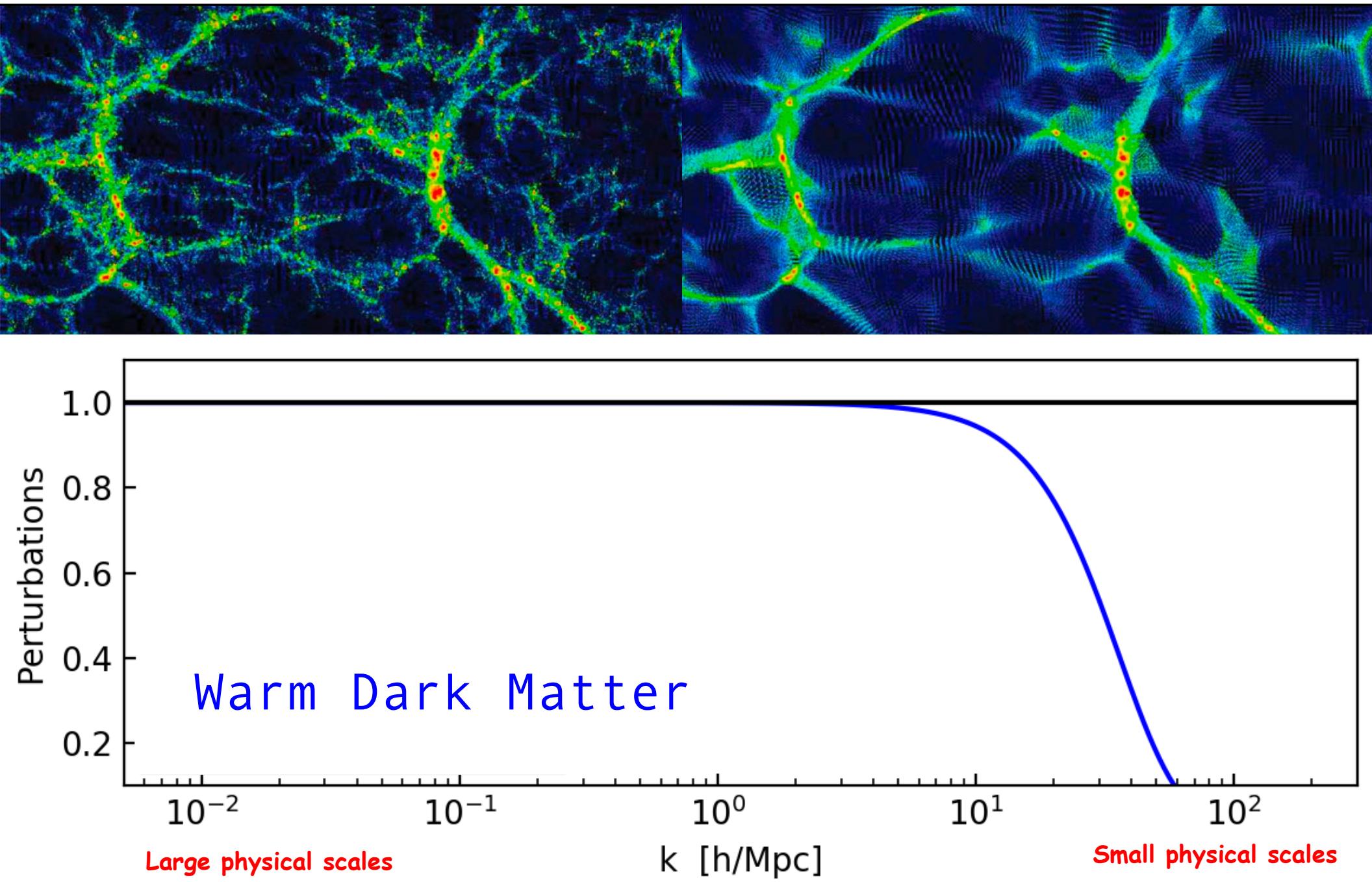
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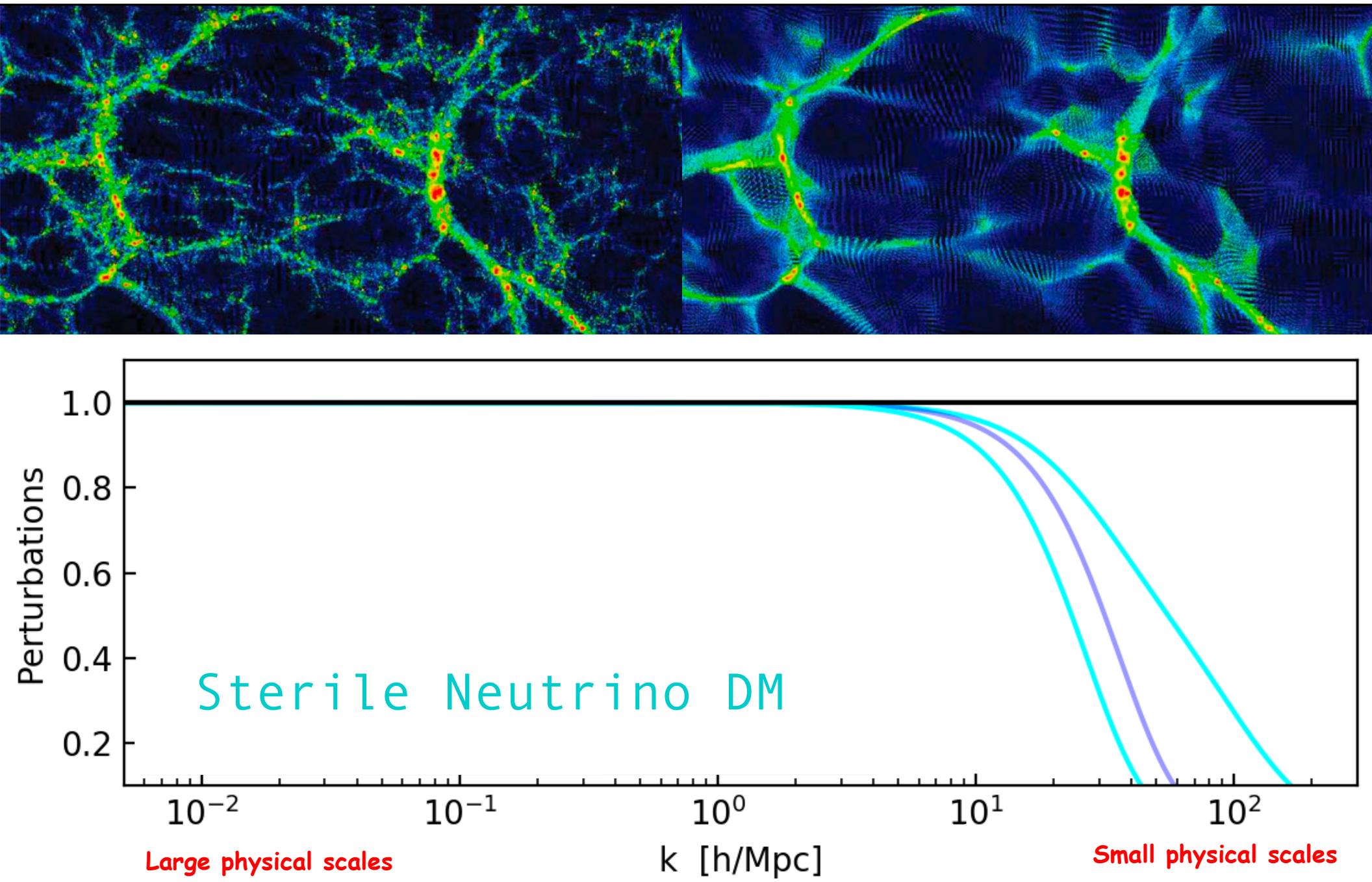
How Dark Matter affects Structure Formation



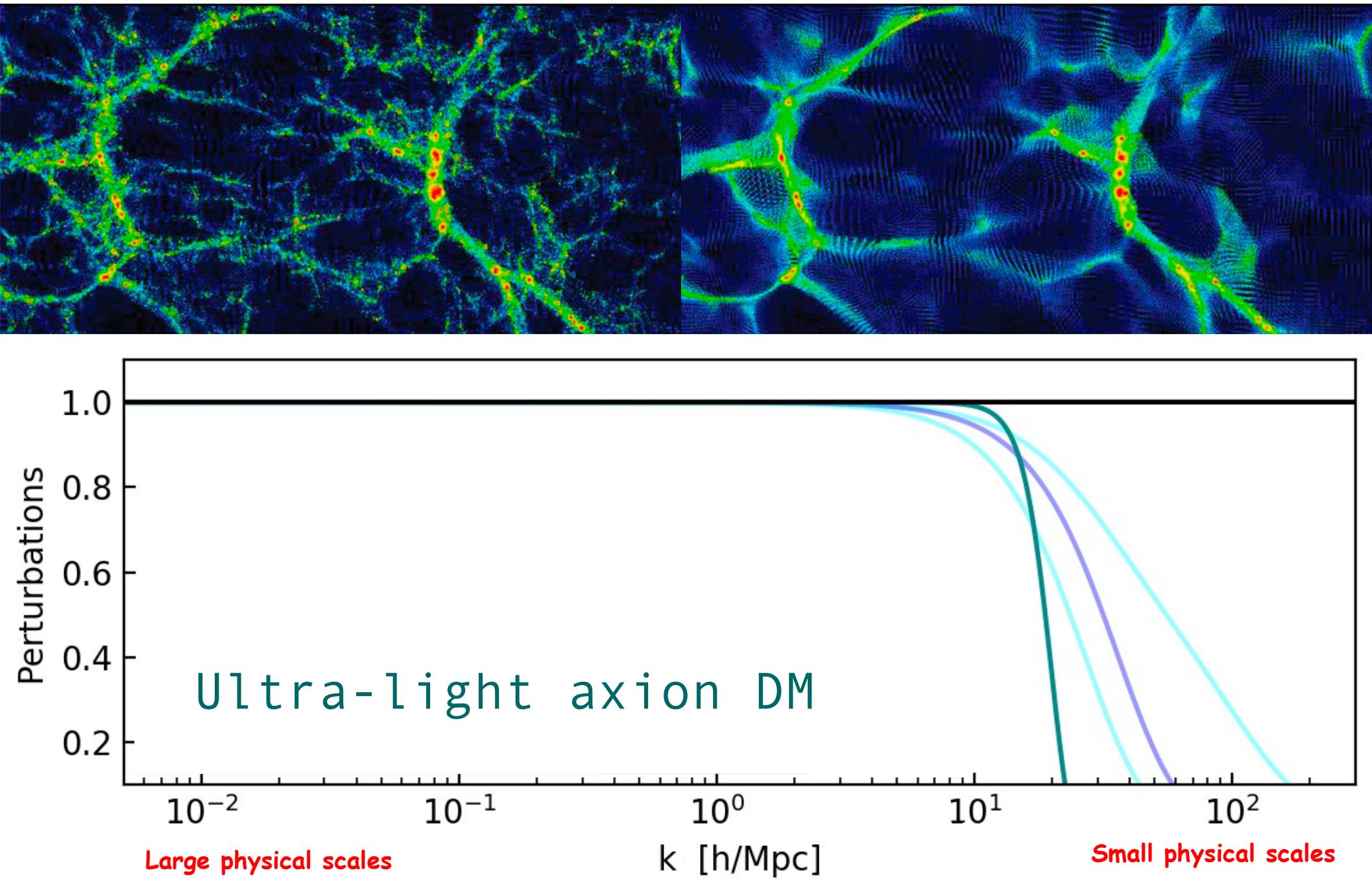
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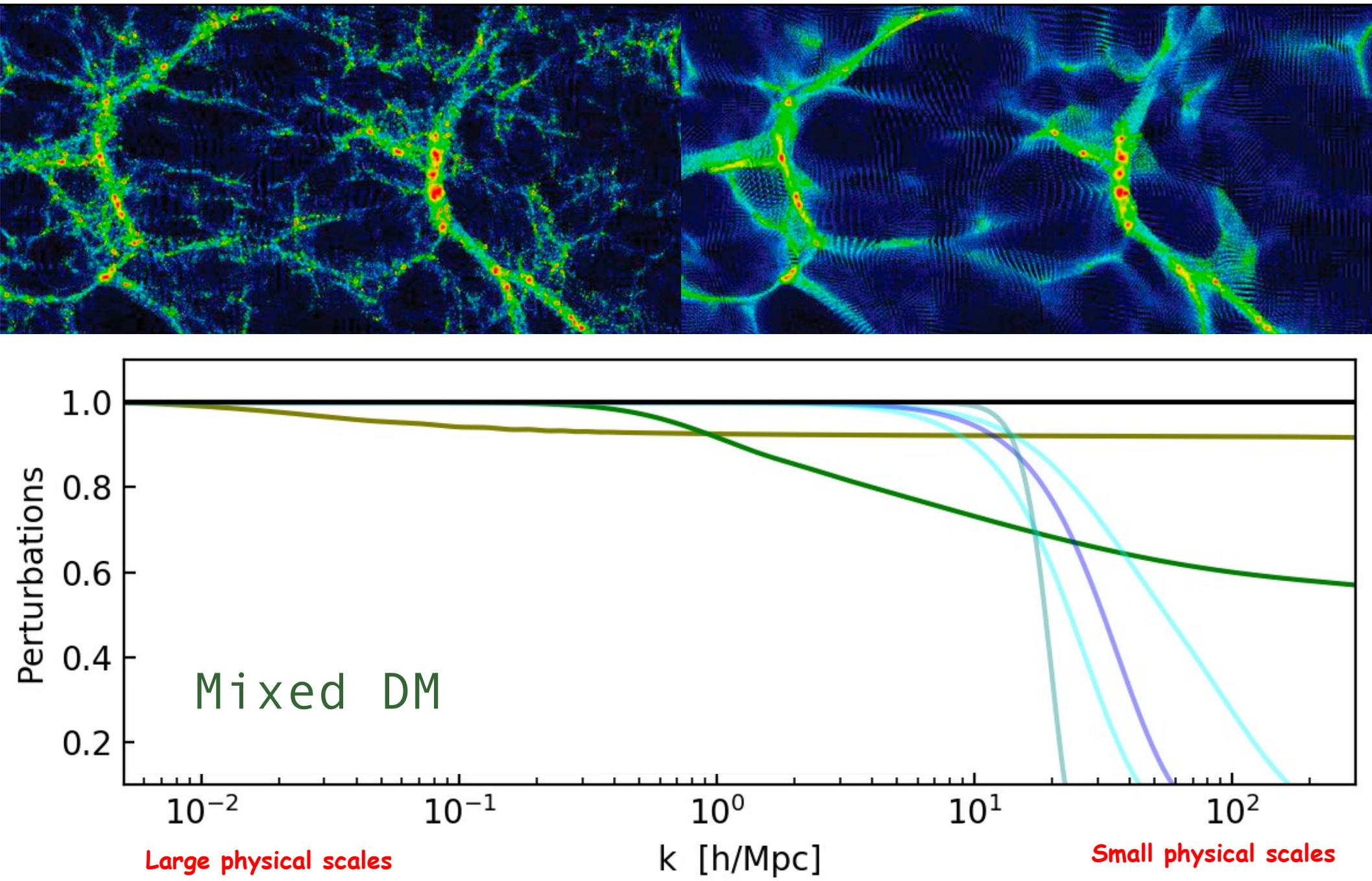
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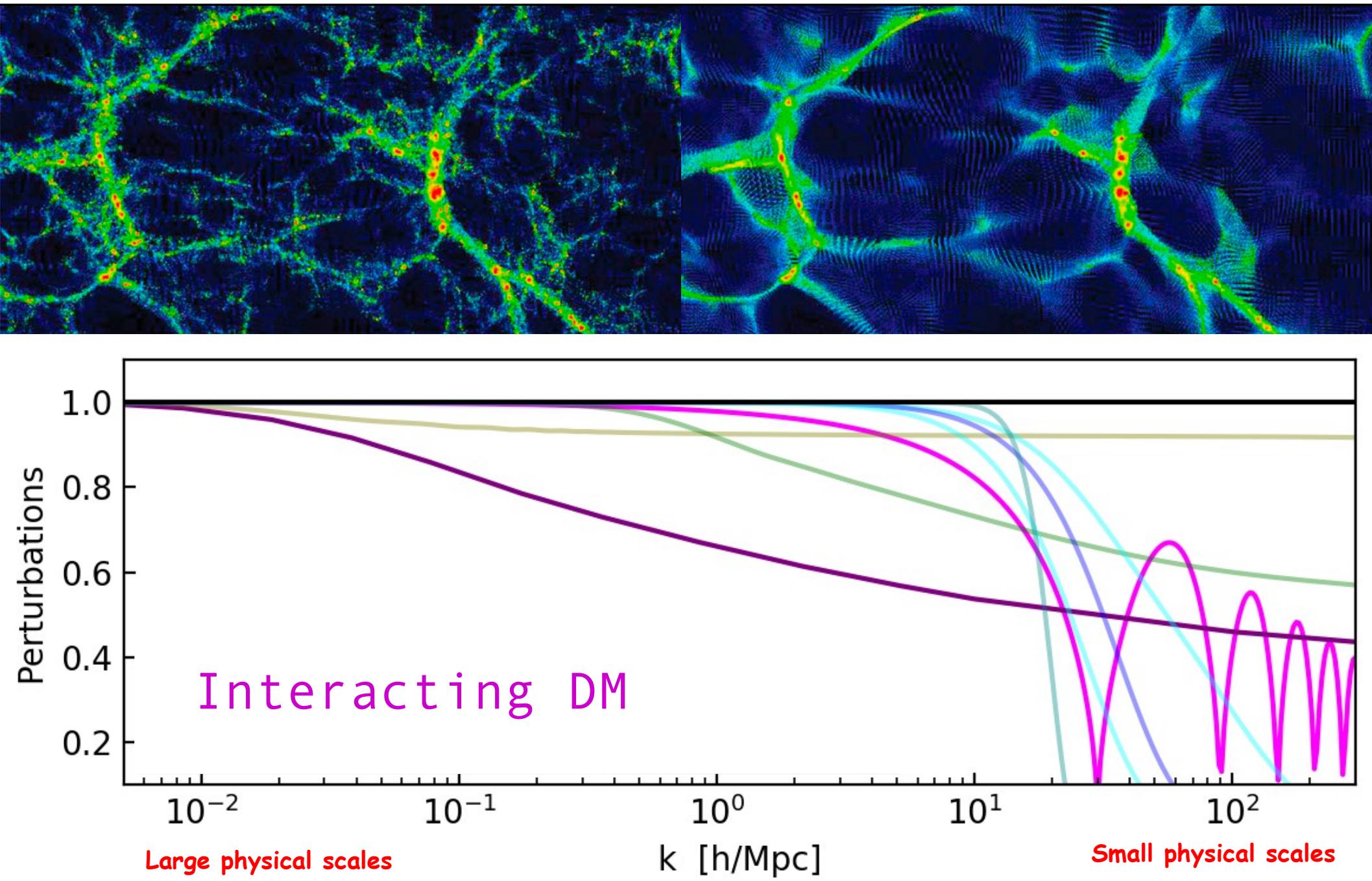
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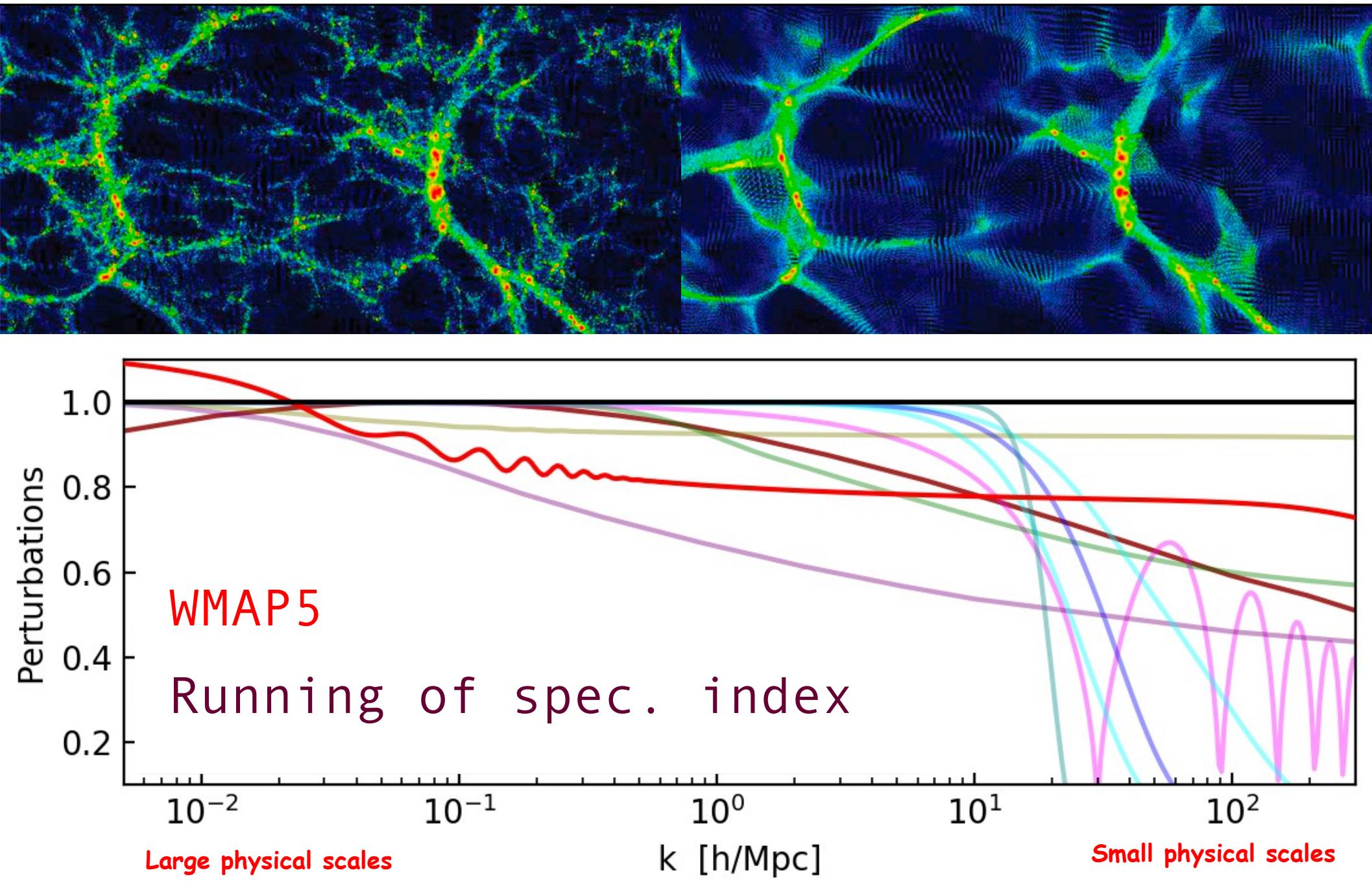
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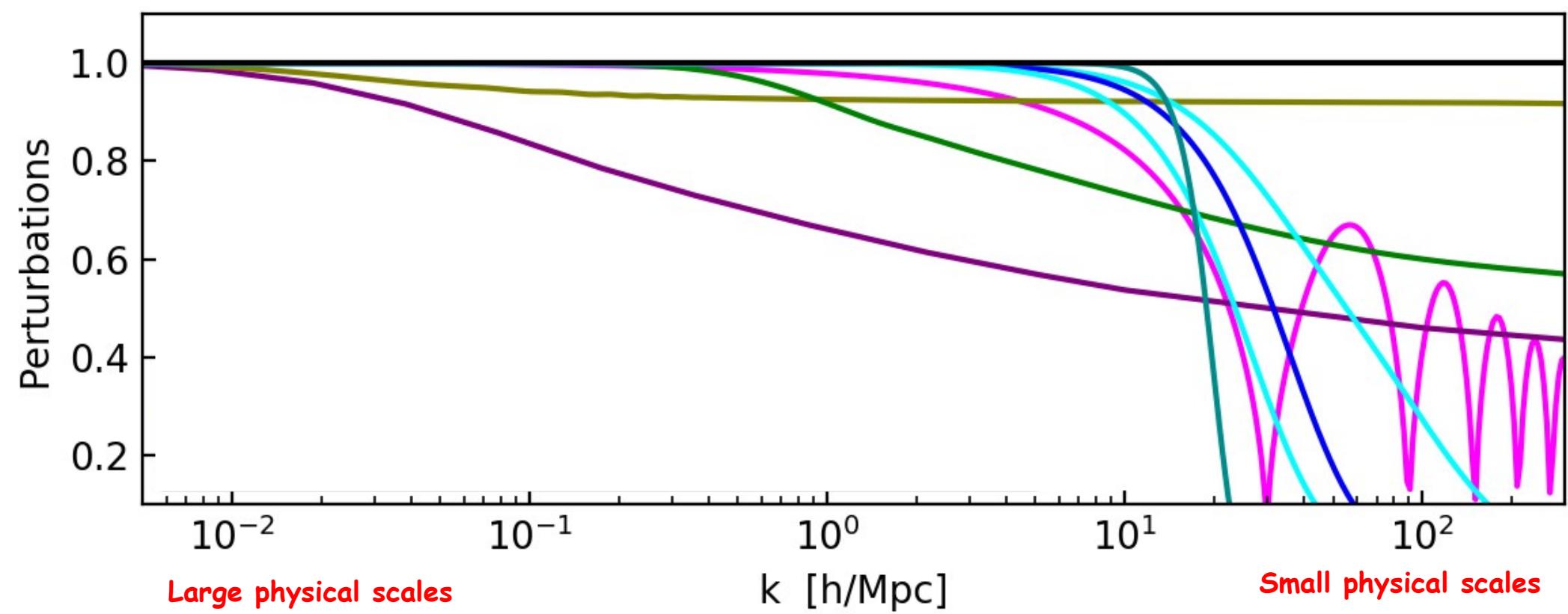
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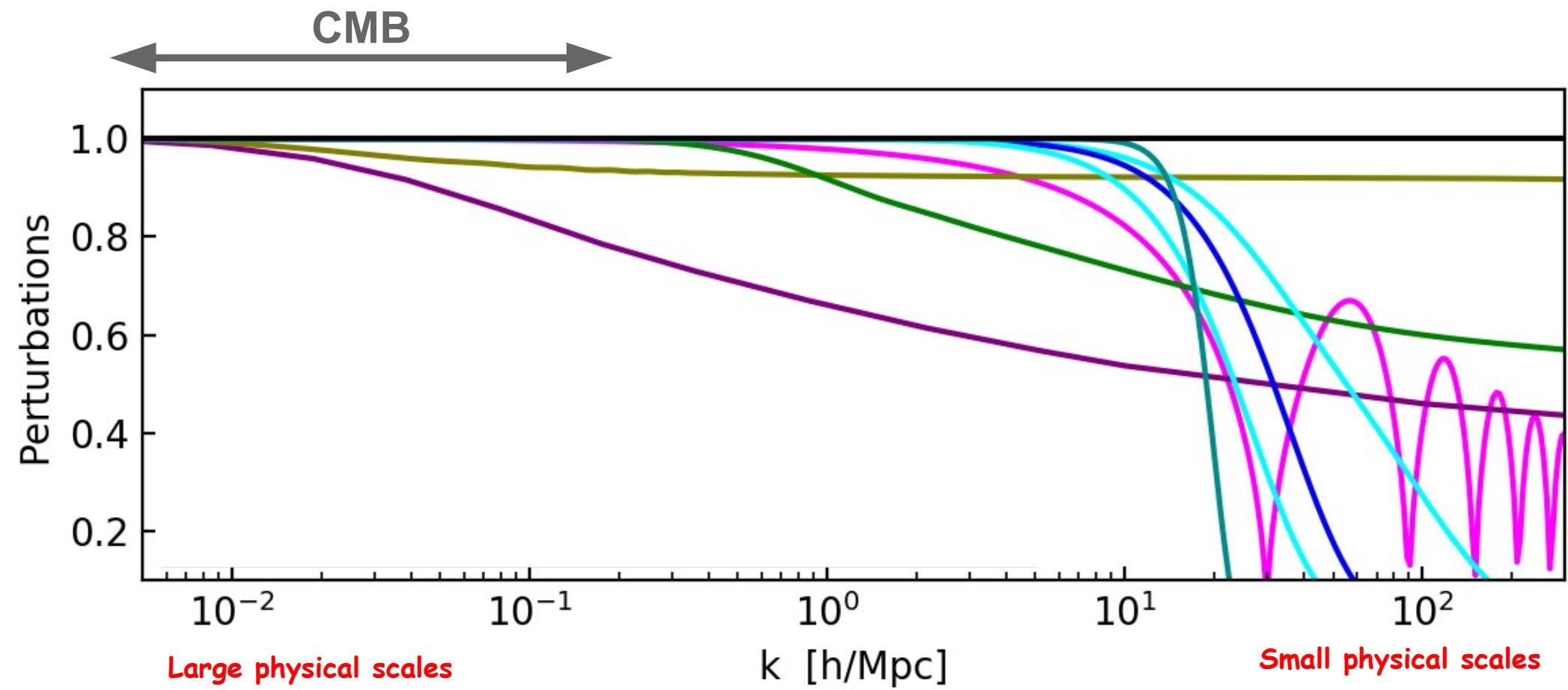
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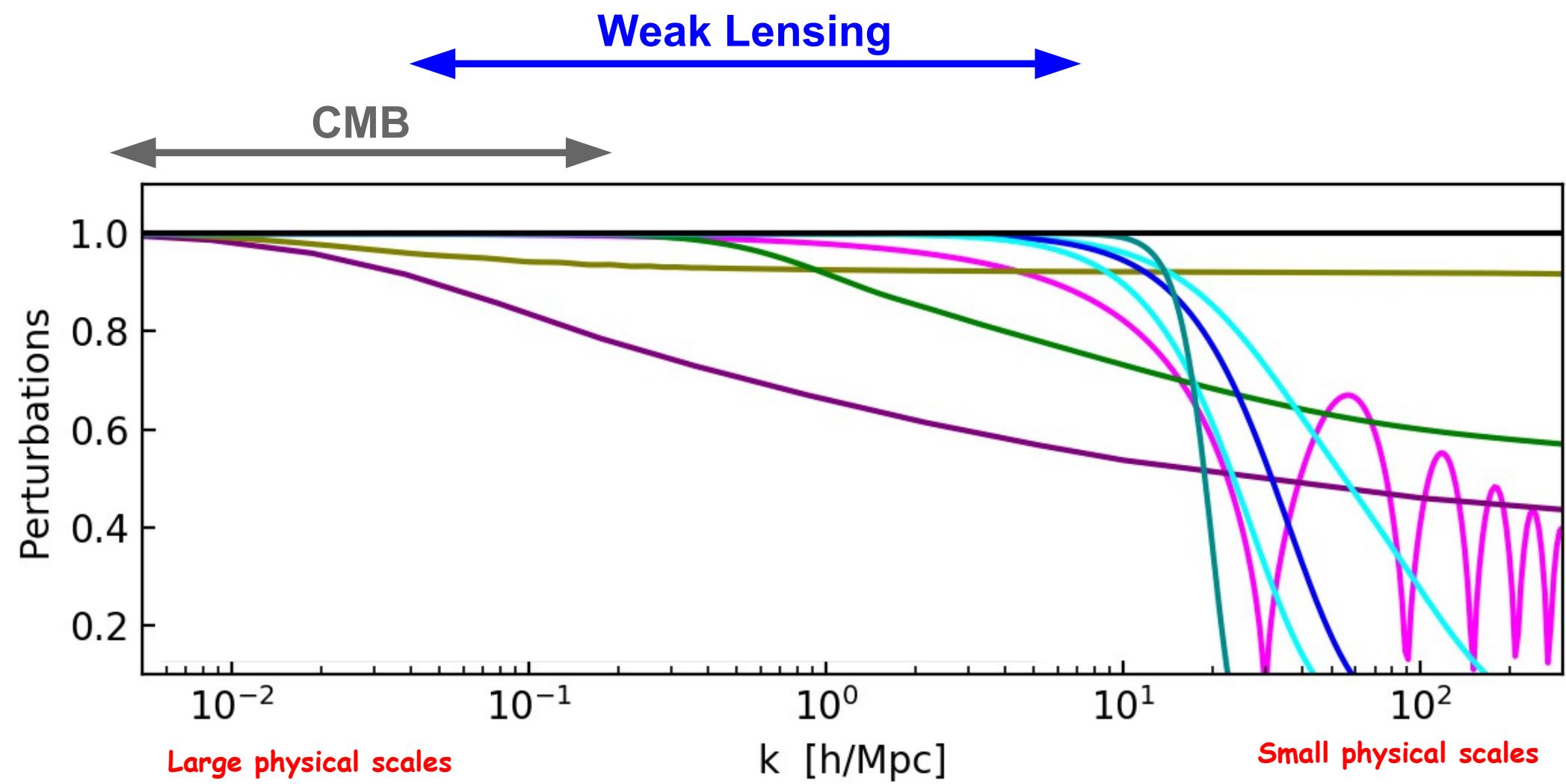
Astrophysical Observables



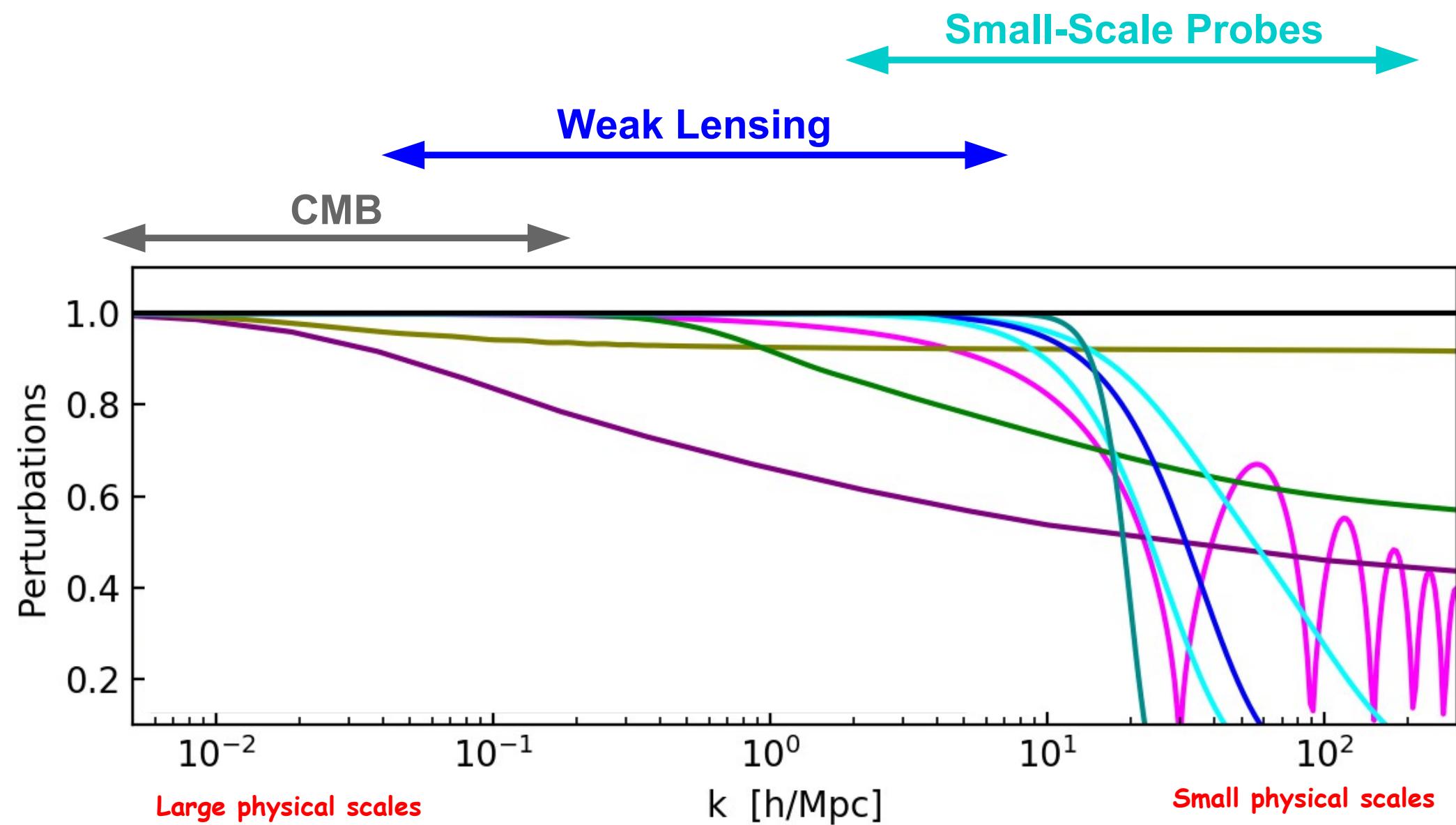
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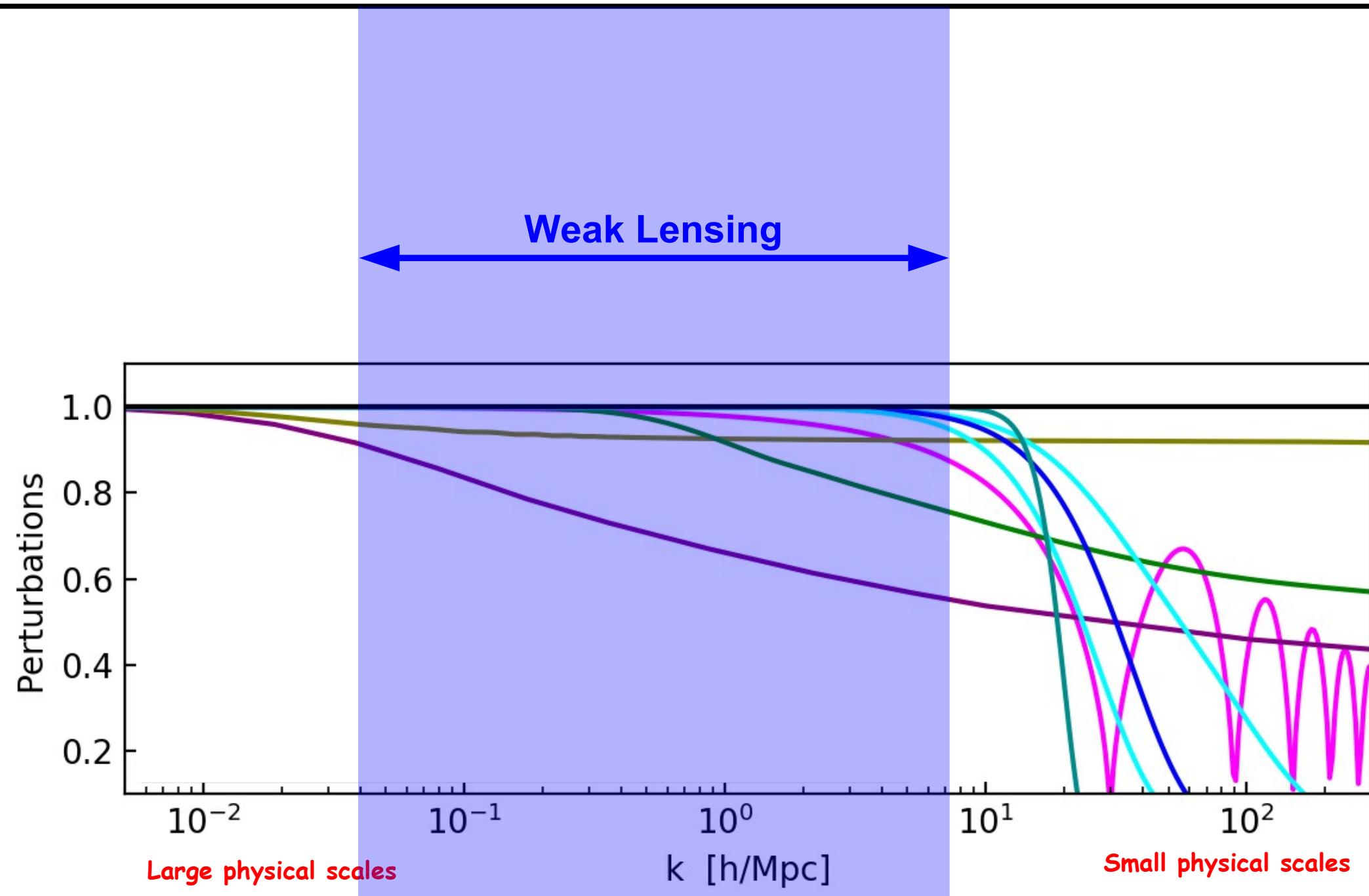
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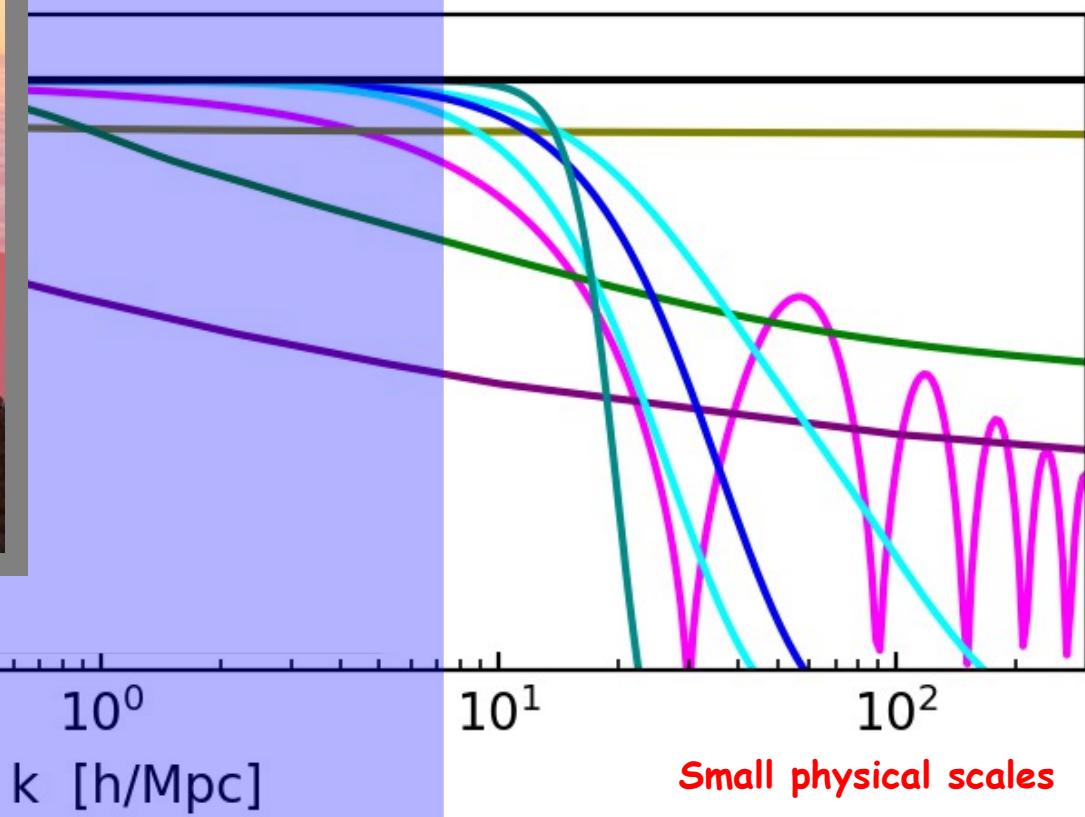
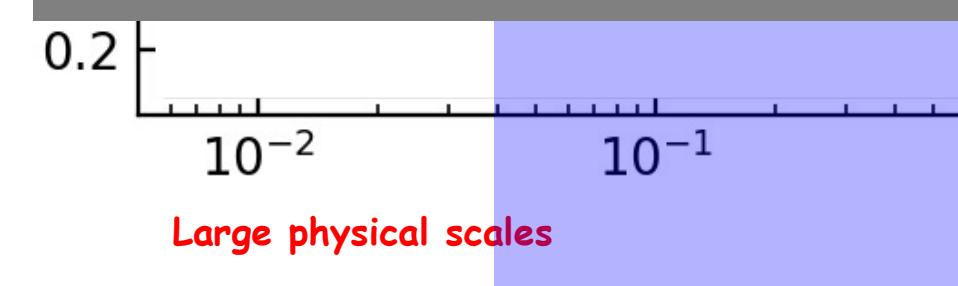
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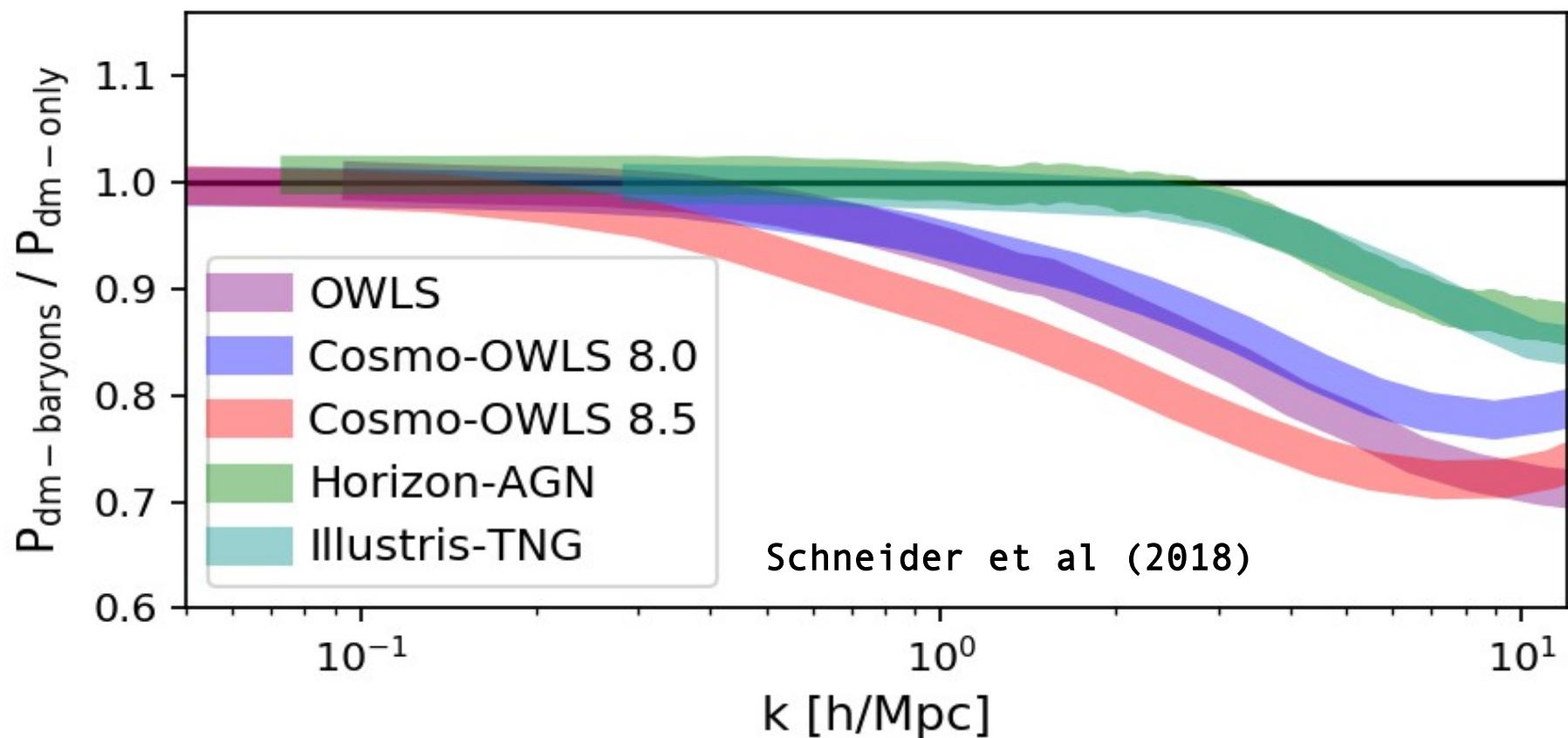
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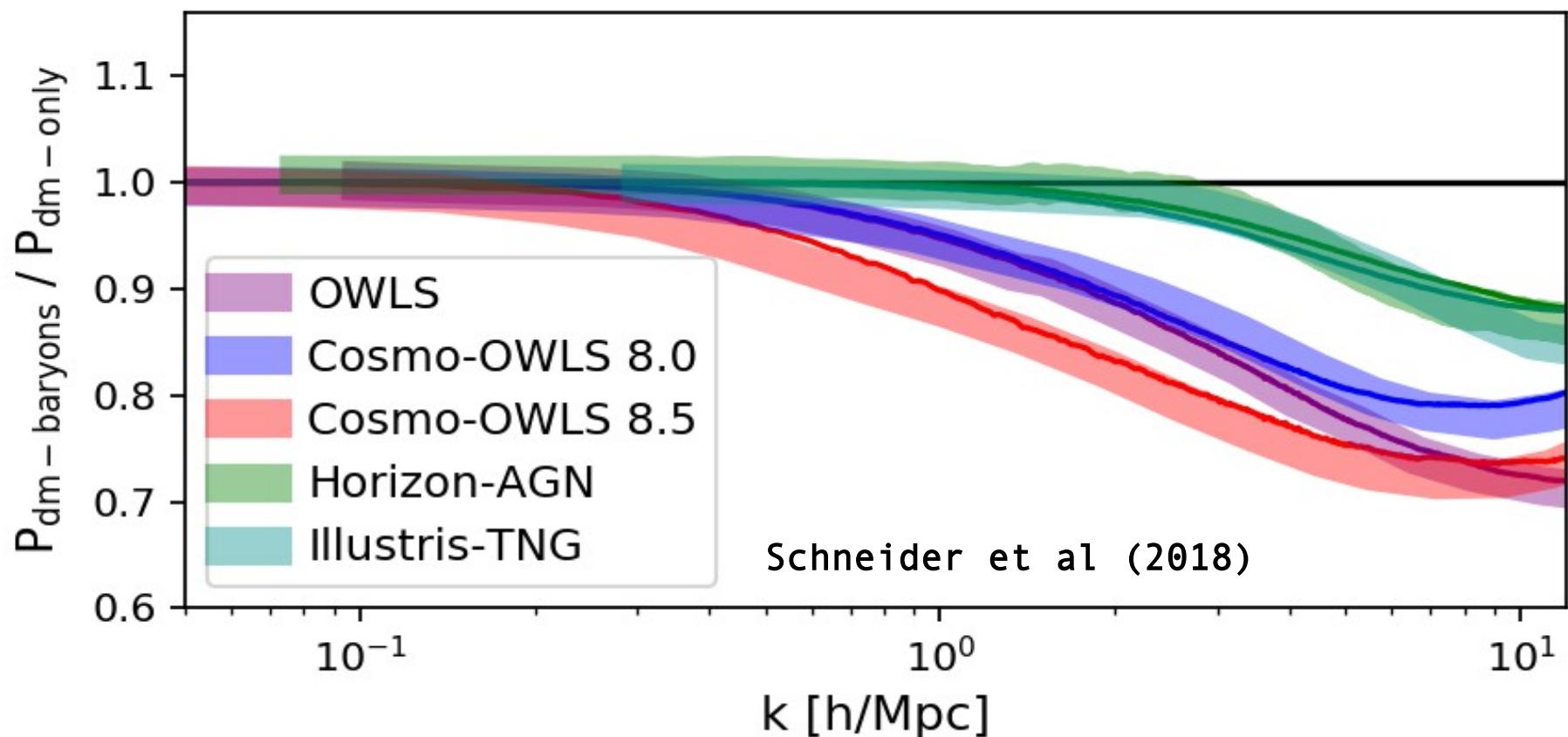


Weak Lensing



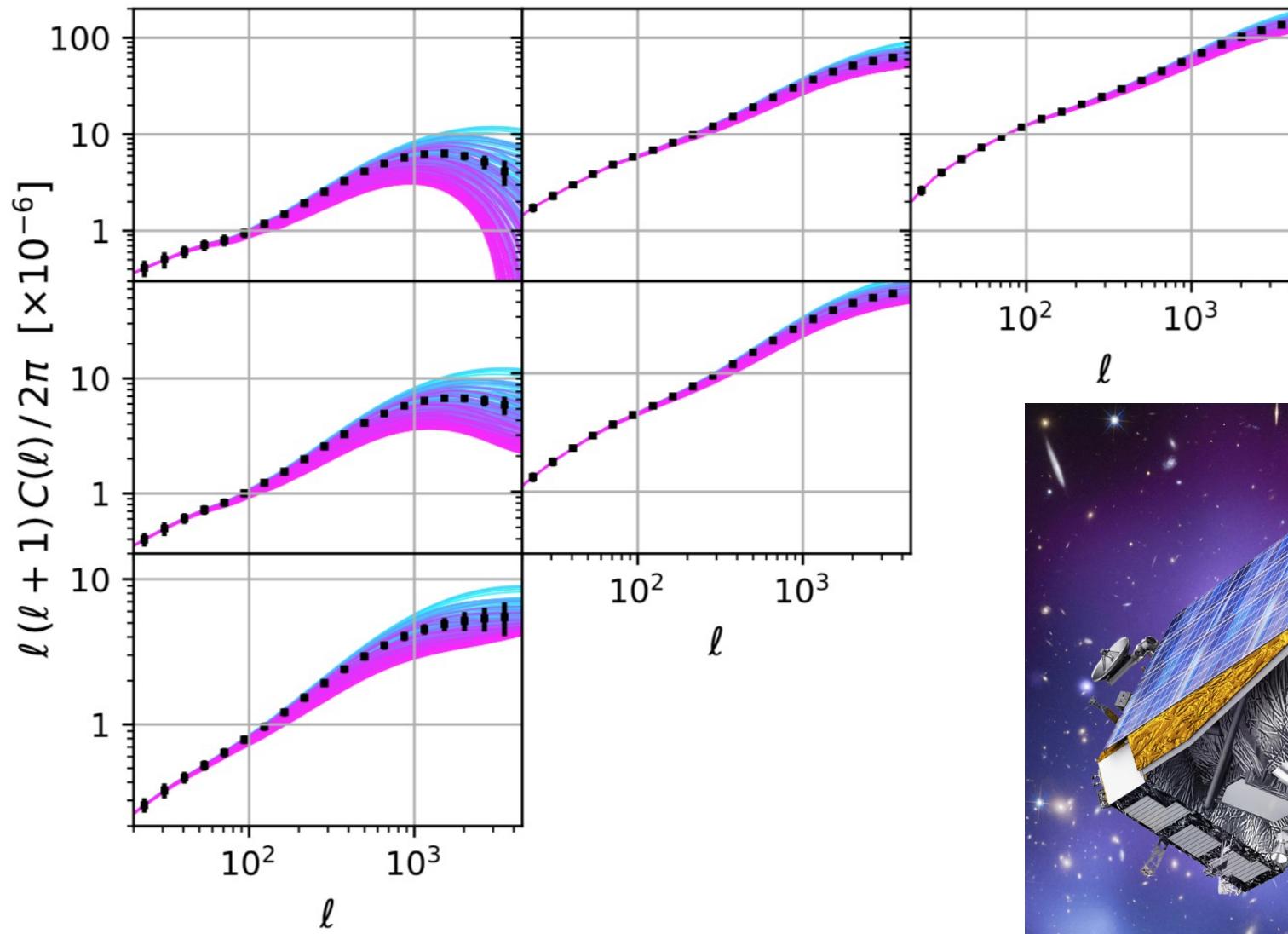
Weak Lensing

Baryonic Correction Model (Schneider+2018) – Empirical model with free parameters (M_c, θ) that can describe simulations/observations and be used for parameter inference.



Weak Lensing – Euclid forecast

Mock data from simulations



Weak Lensing – Euclid forecast

Neutrino Masses

MCMC param. inference

6 cosmological,

3 baryonic,

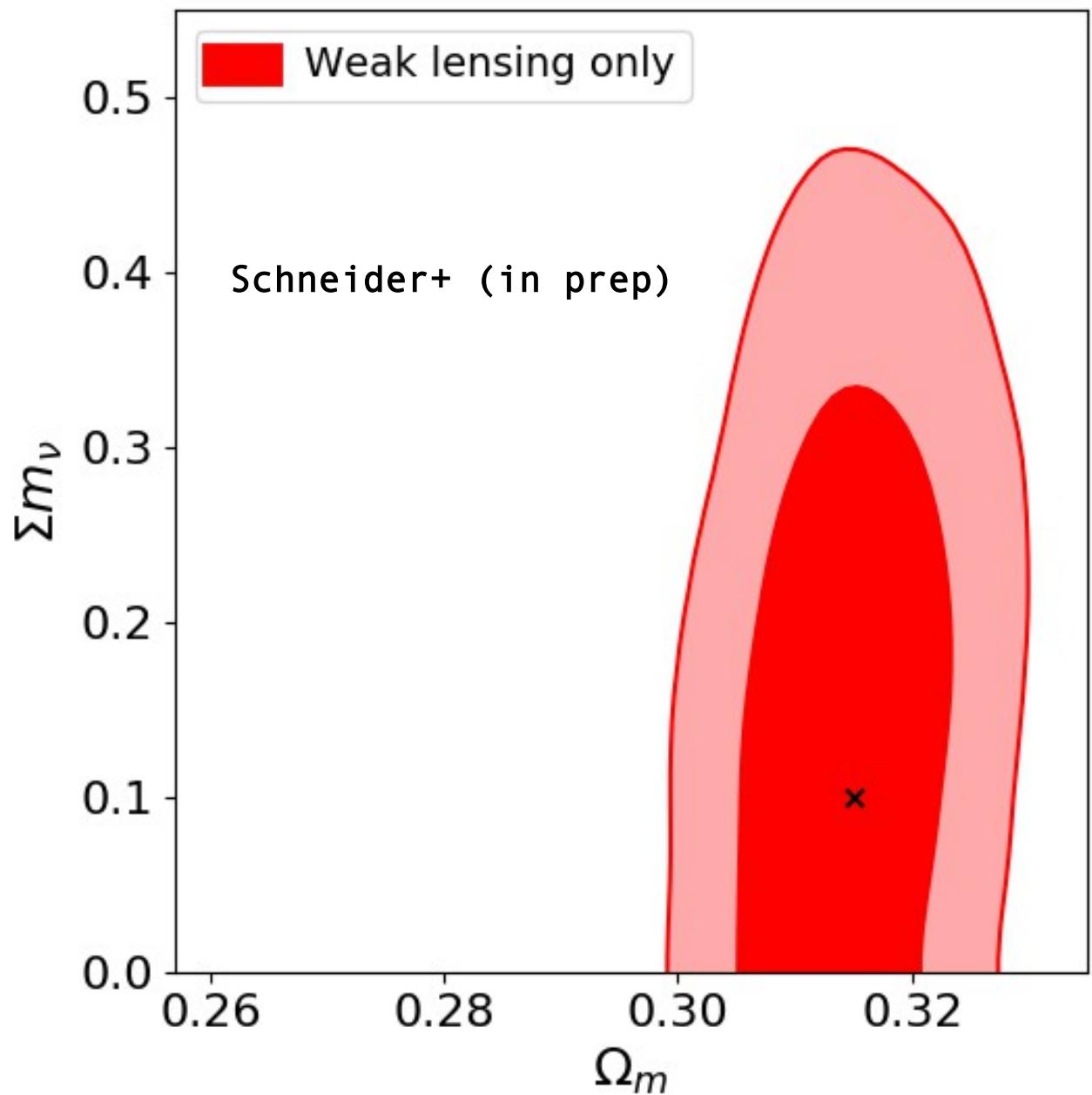
1 IA parameters

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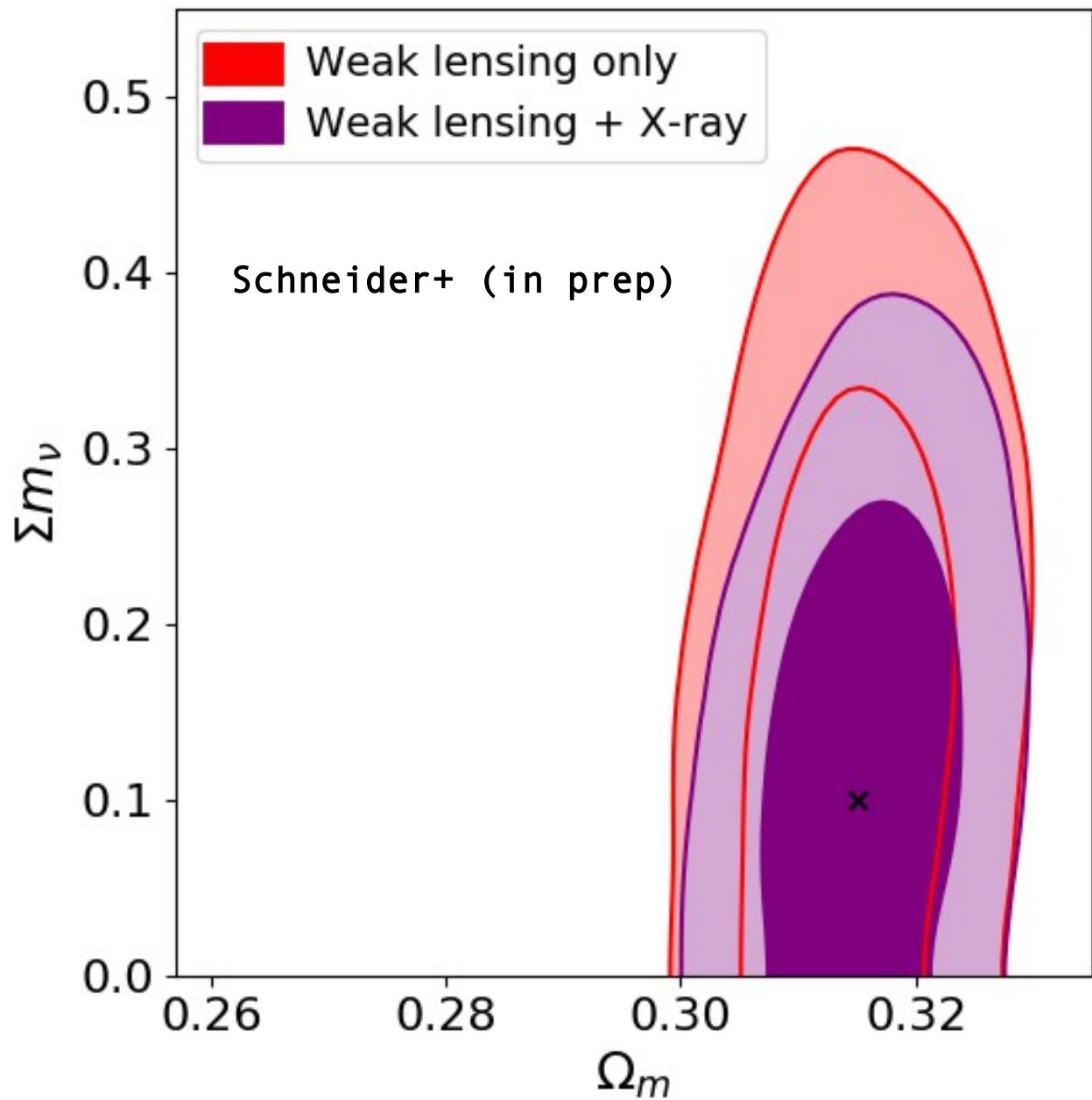


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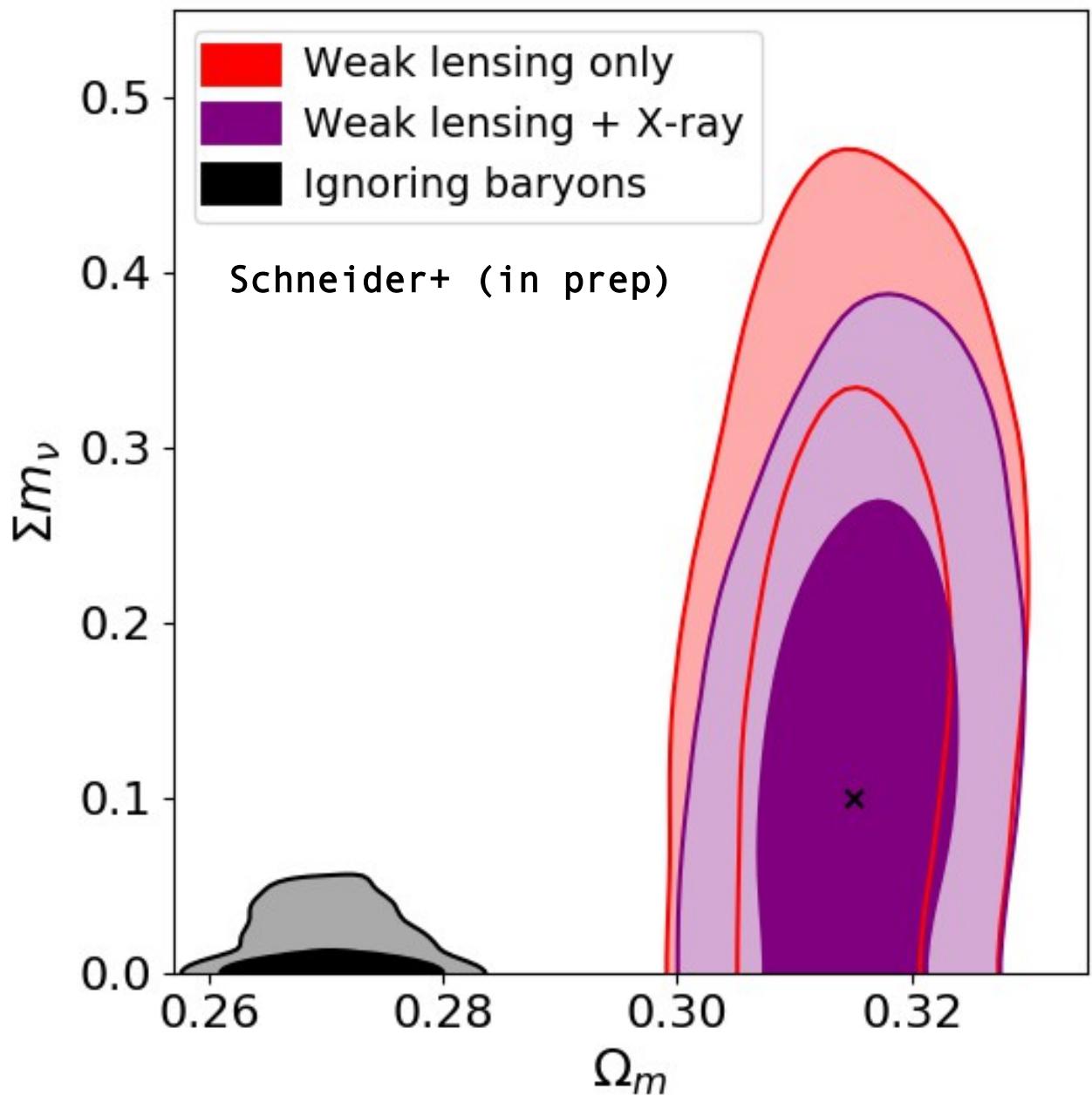


Weak Lensing – Euclid forecast

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Weak Lensing – Euclid forecast

Mixed dark matter

MCMC param. inference

6 cosmological,

2 dark matter

3 baryonic,

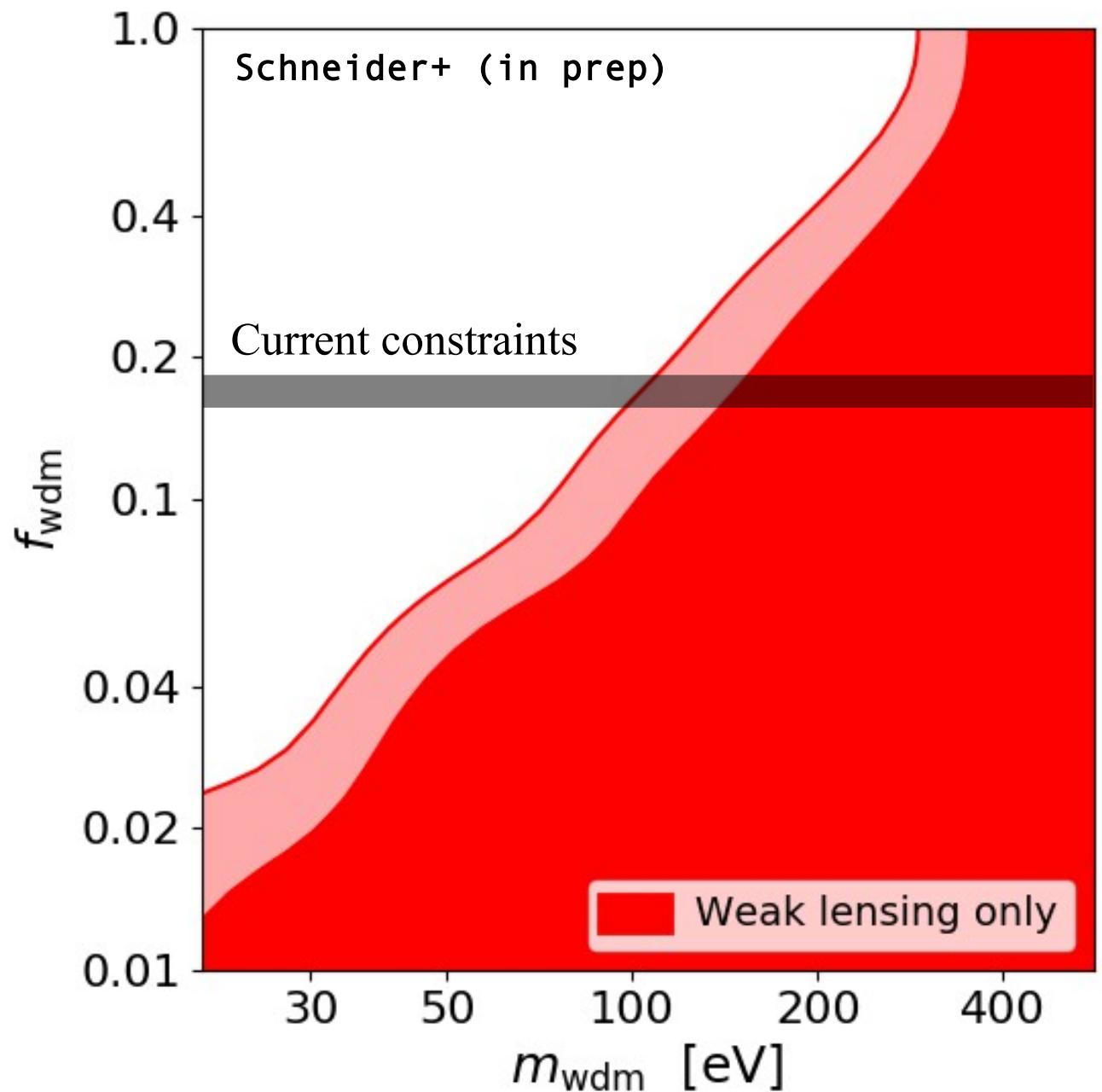
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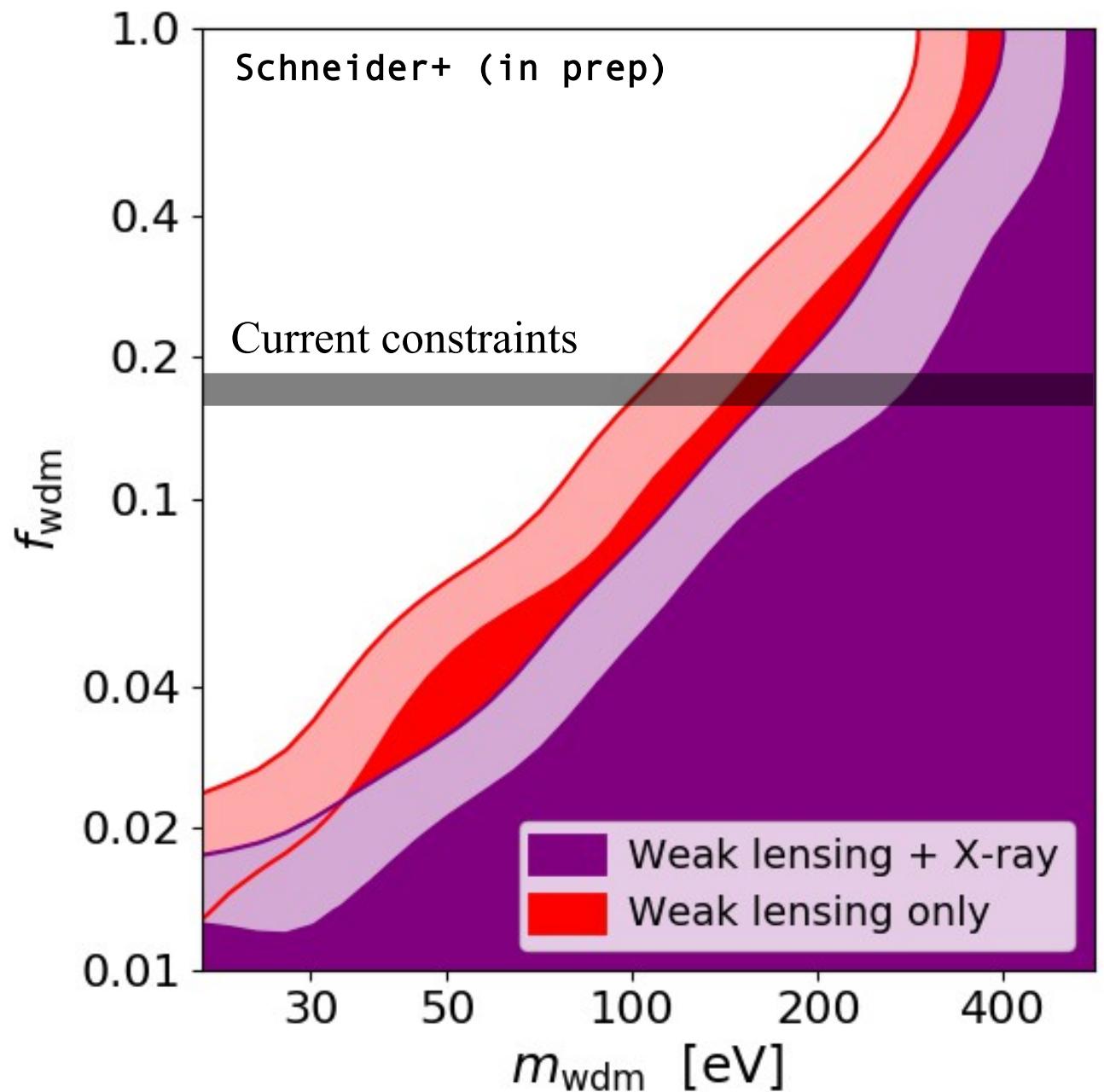


Weak Lensing – Euclid forecast

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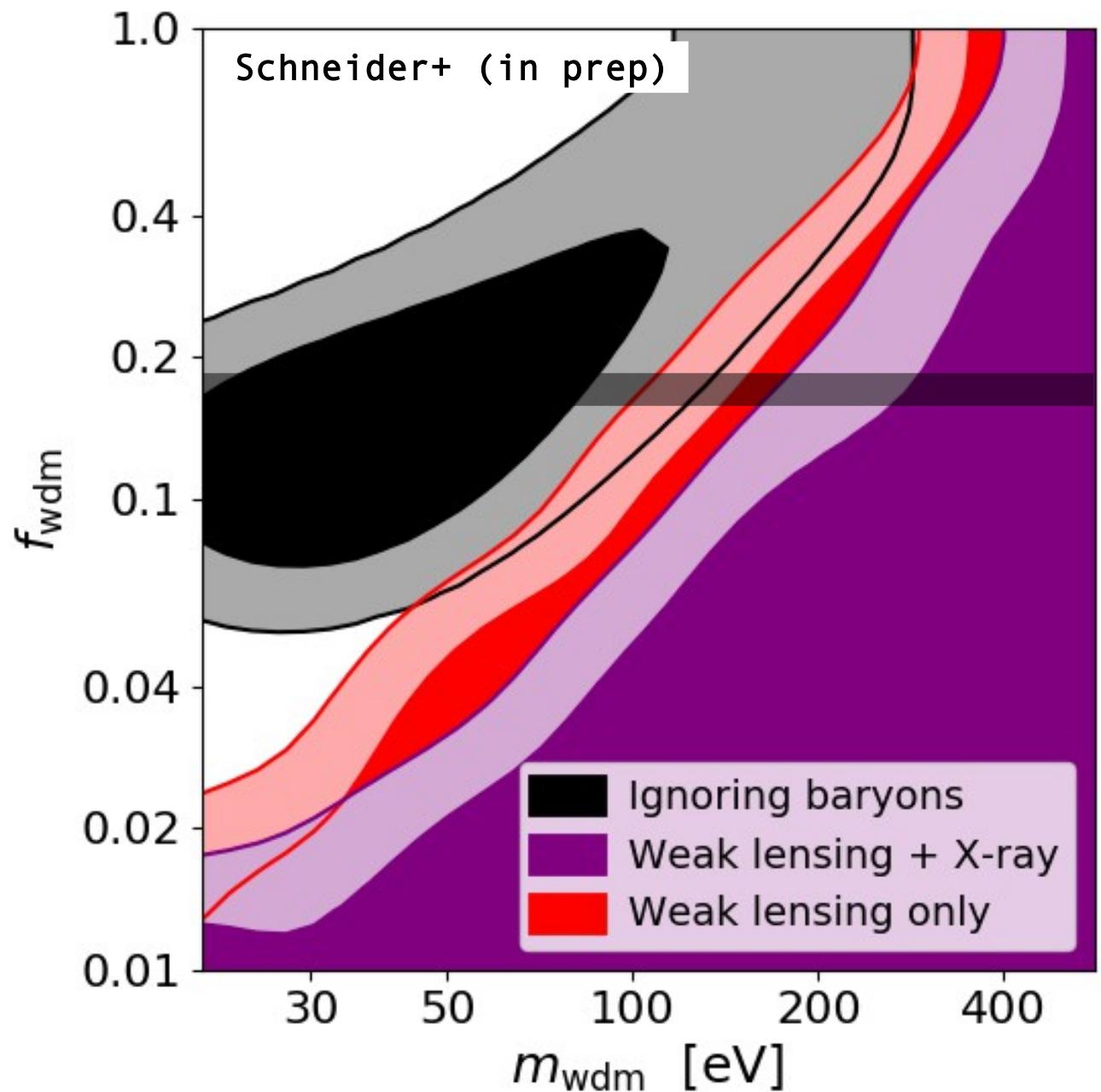


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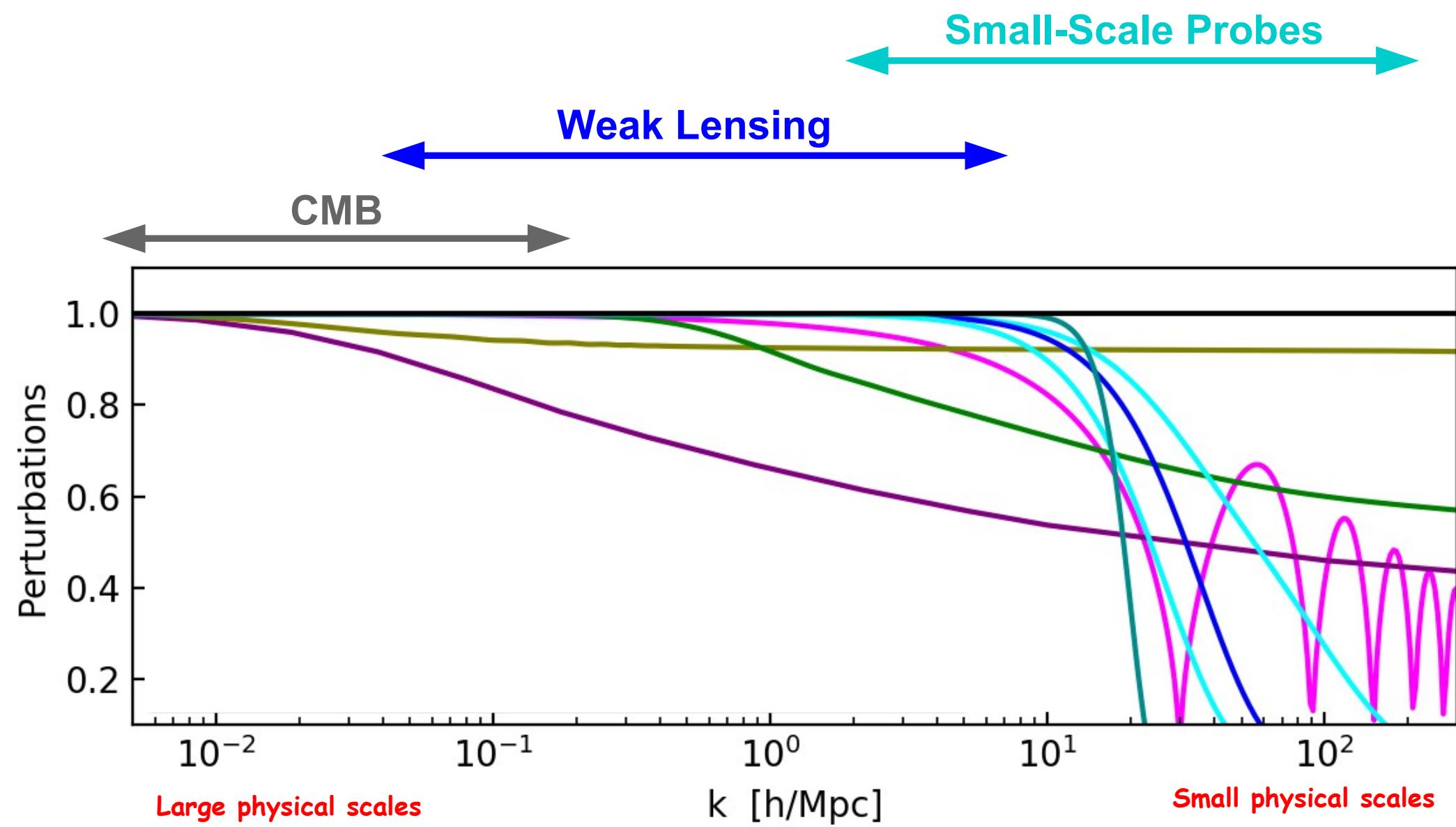
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MCMC param. inference

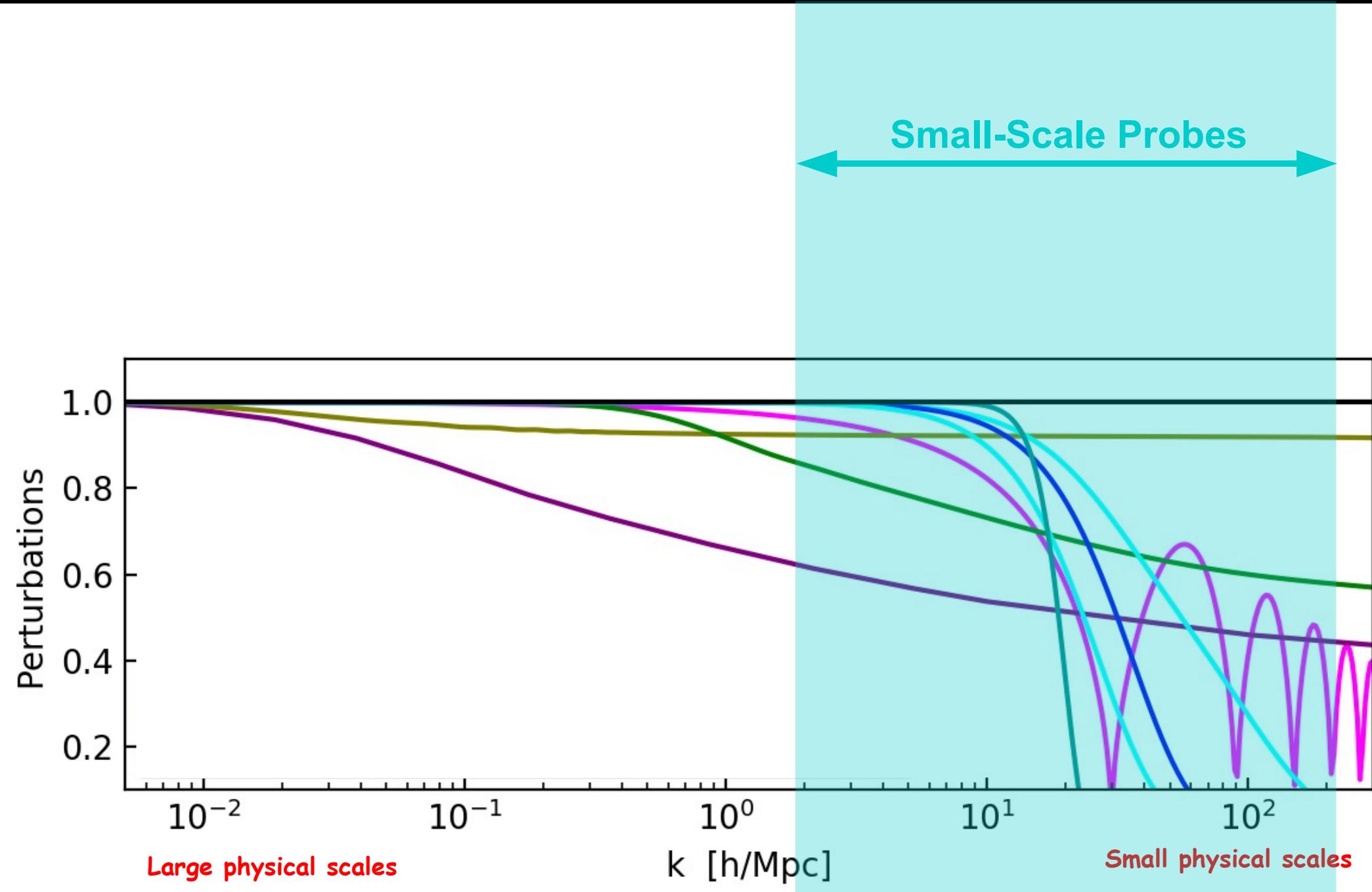
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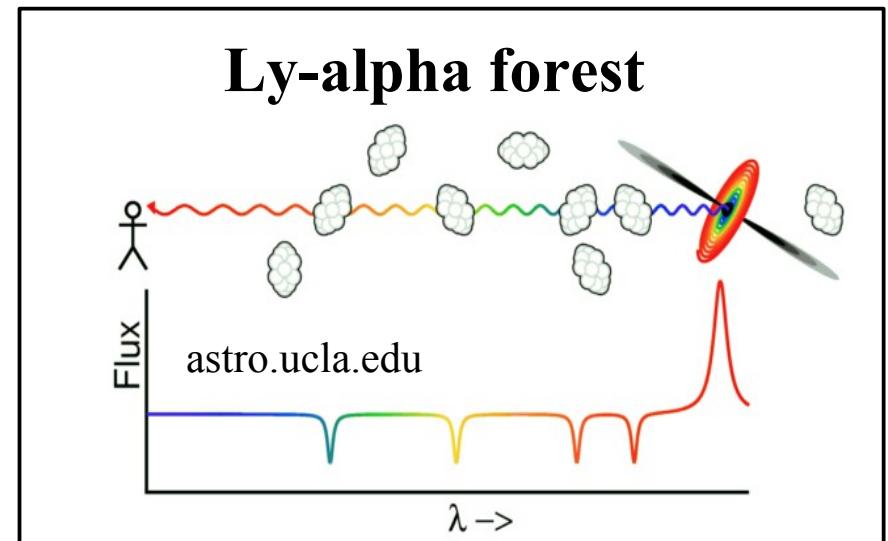
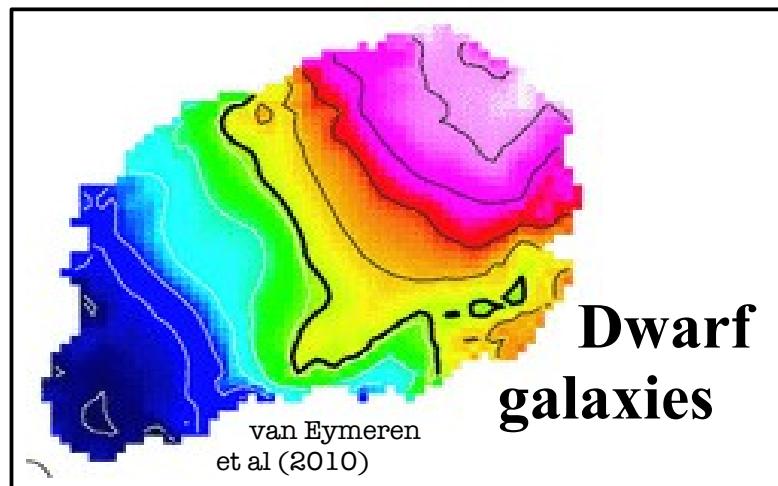
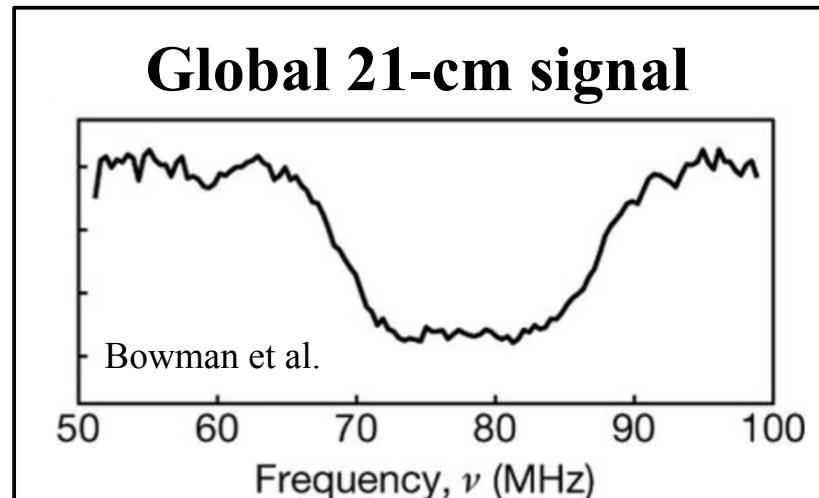
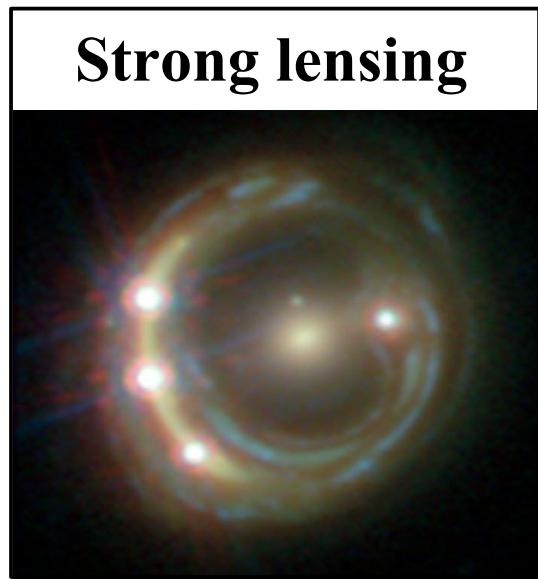
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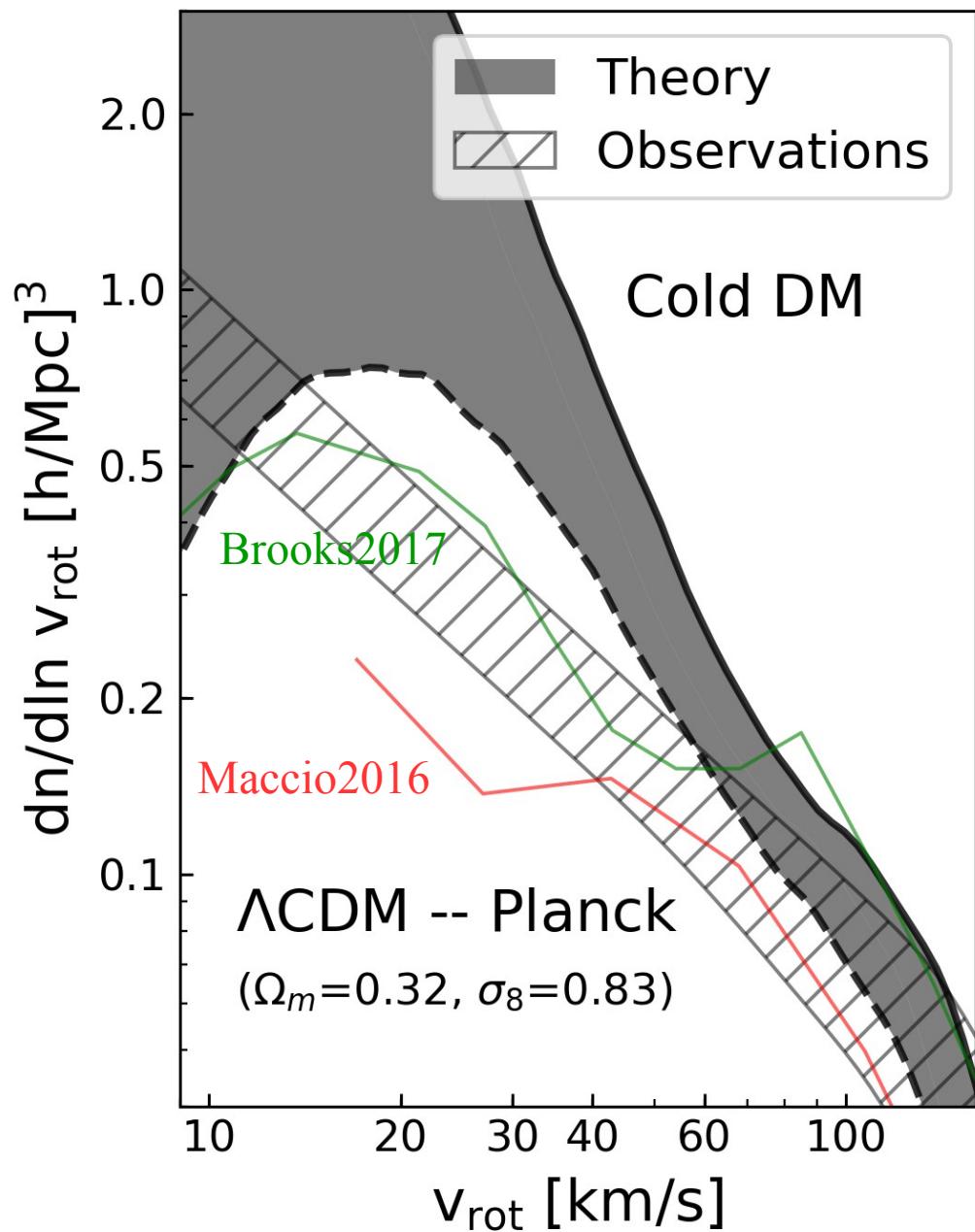
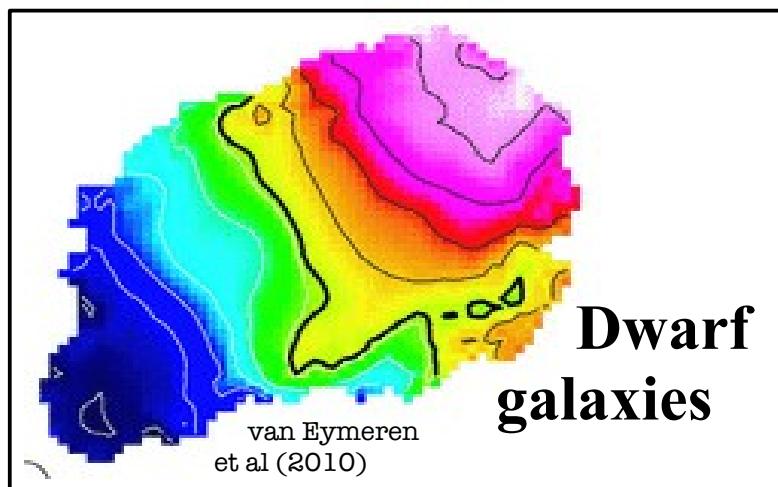


Small-Scale Probes



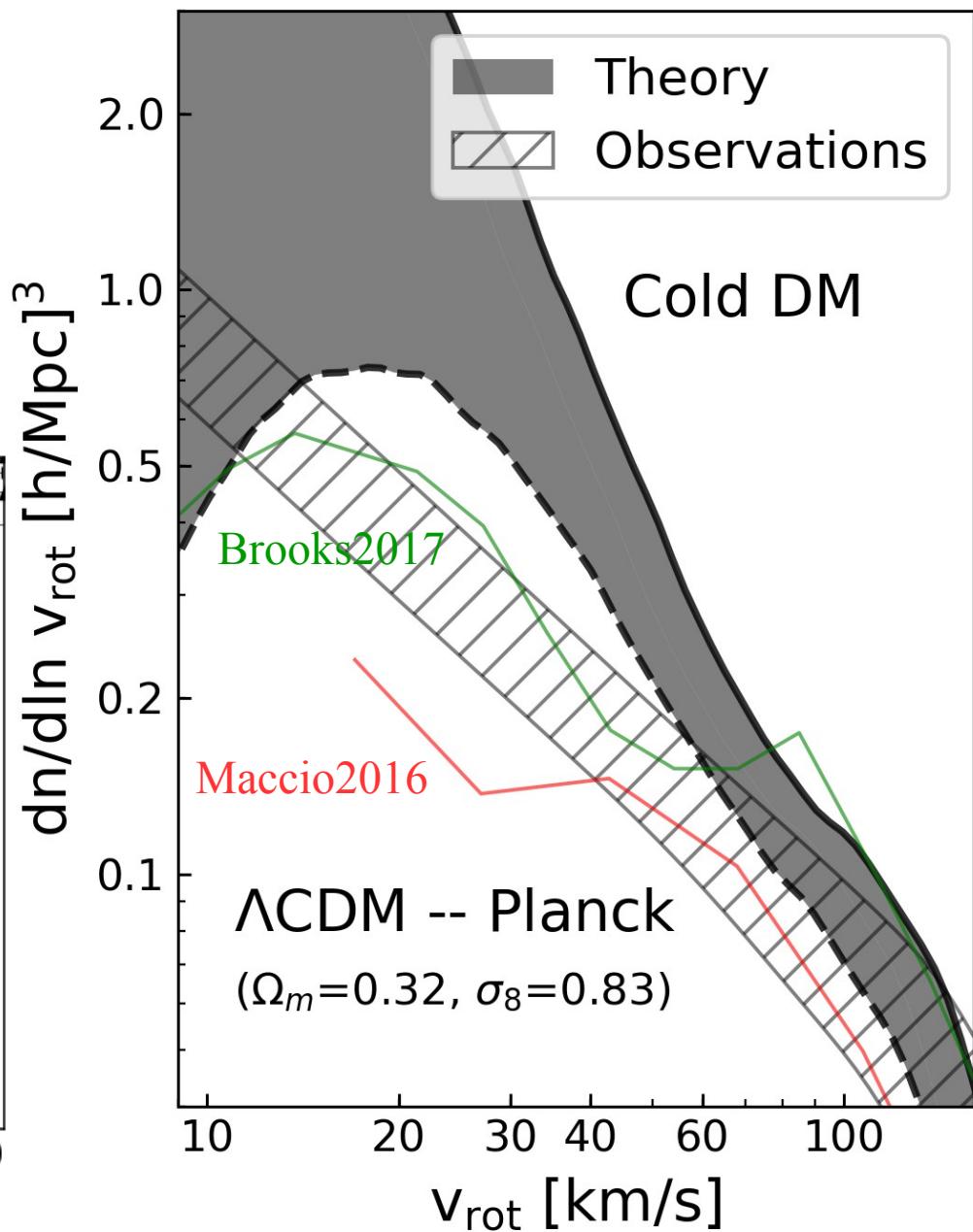
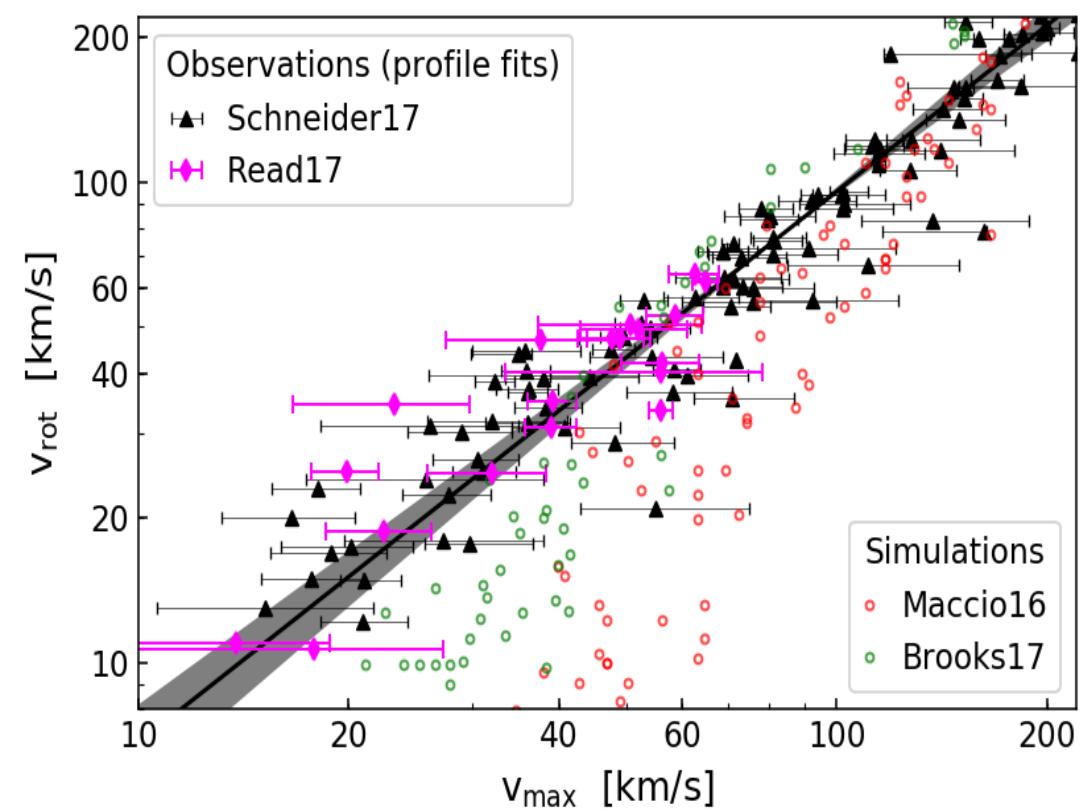
Dwarf galaxies in the local universe

Velocity function: number of galaxies per rotation velocity.



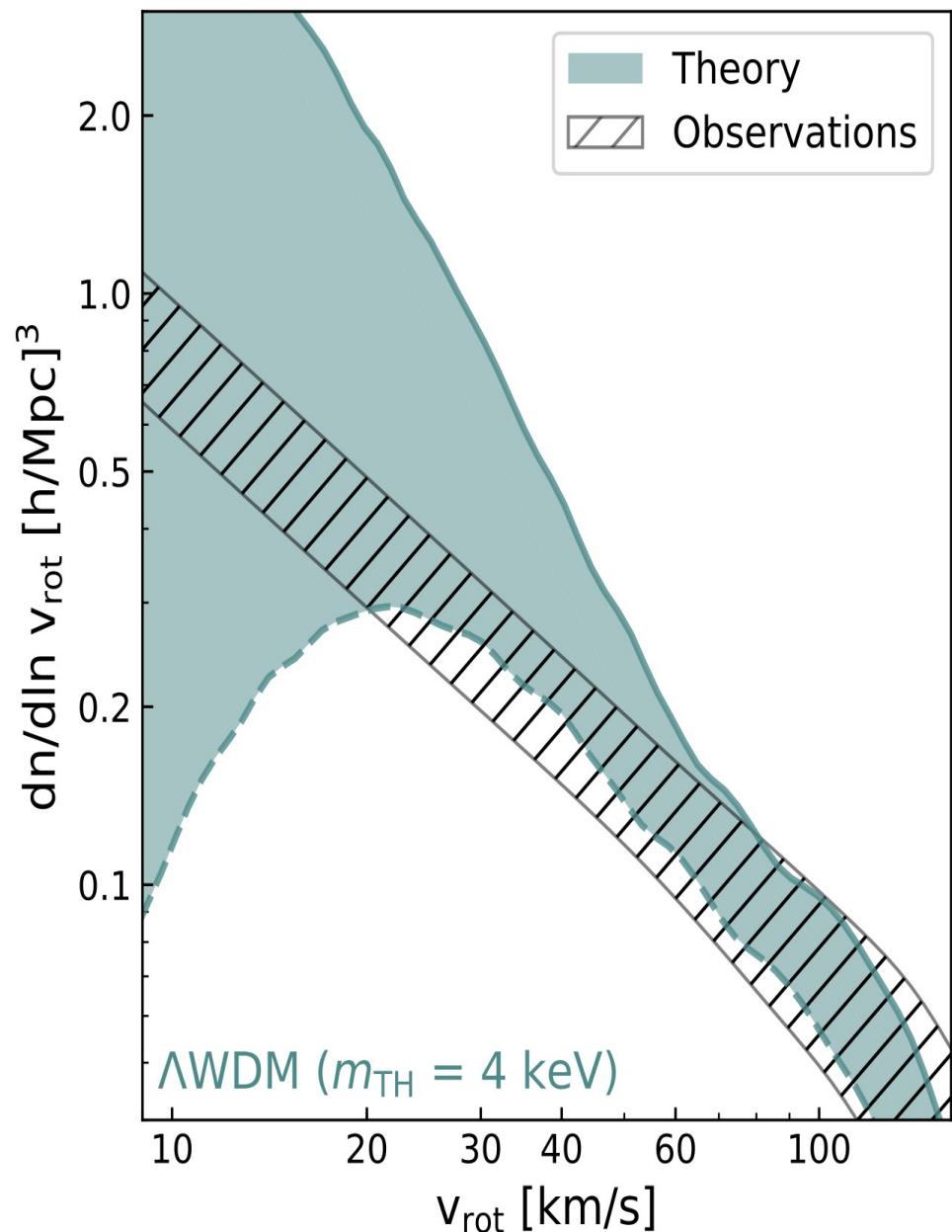
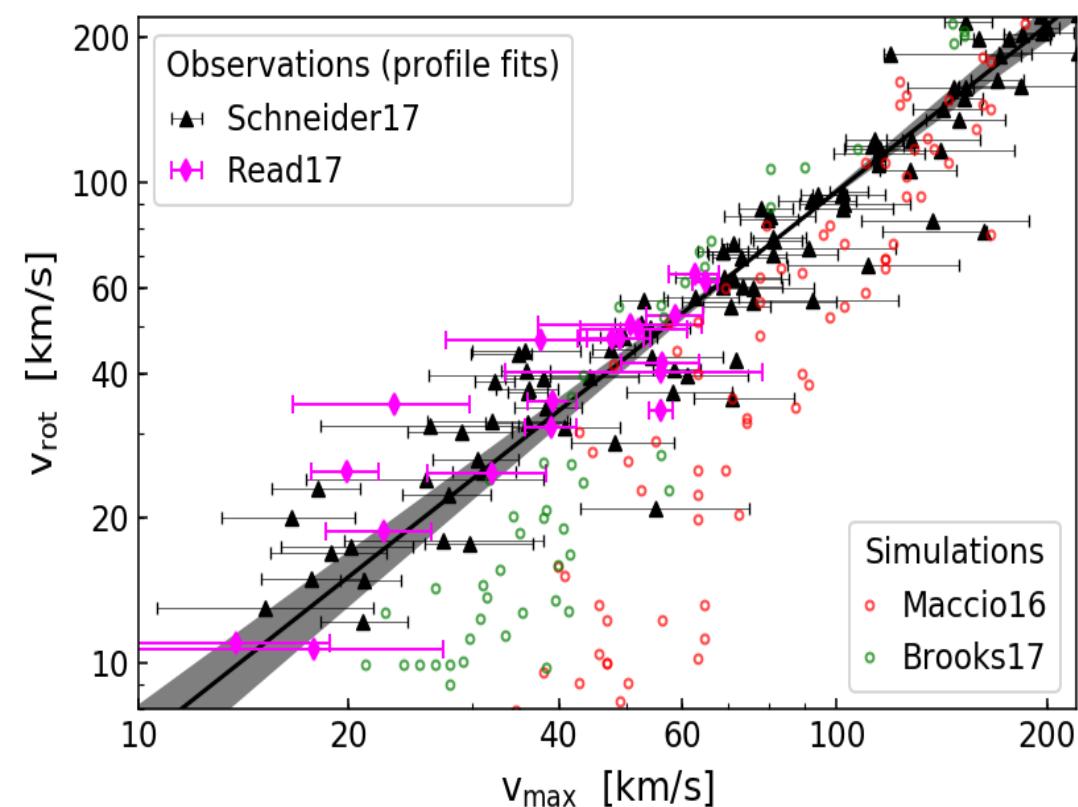
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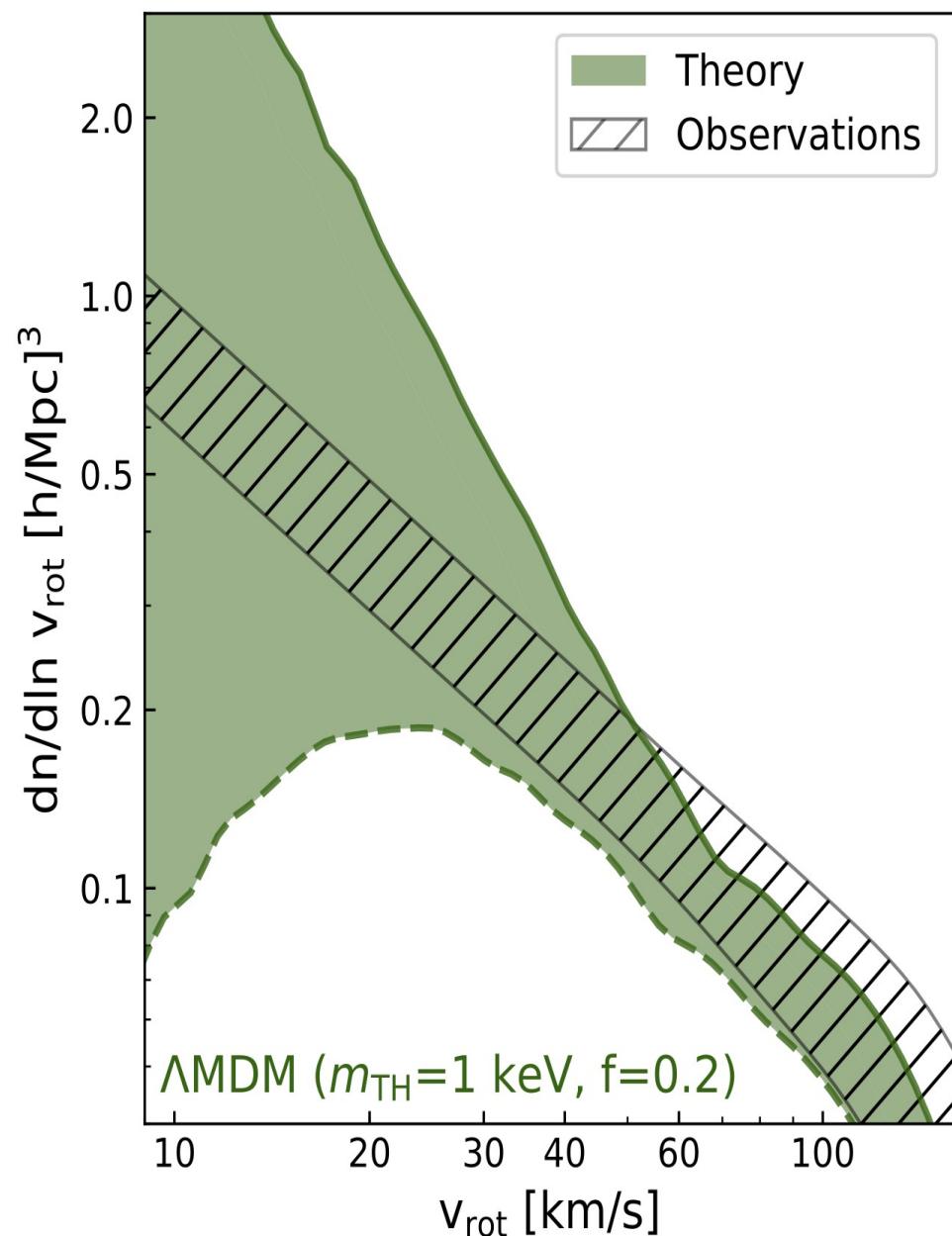
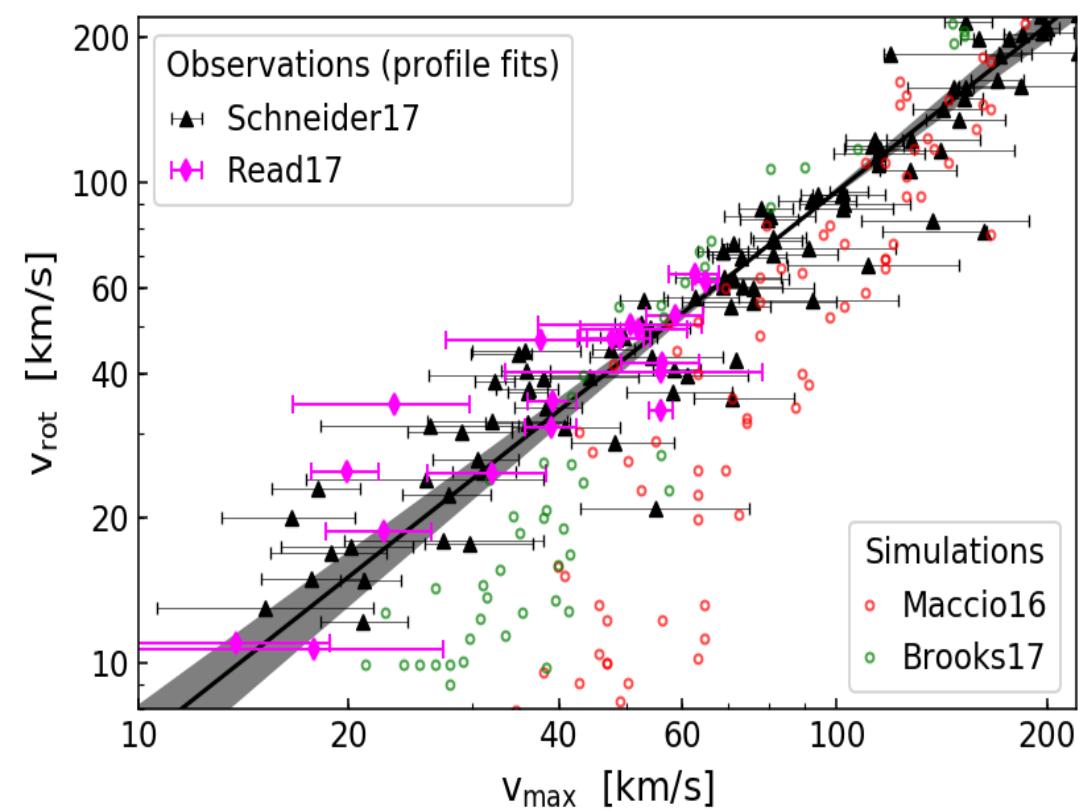
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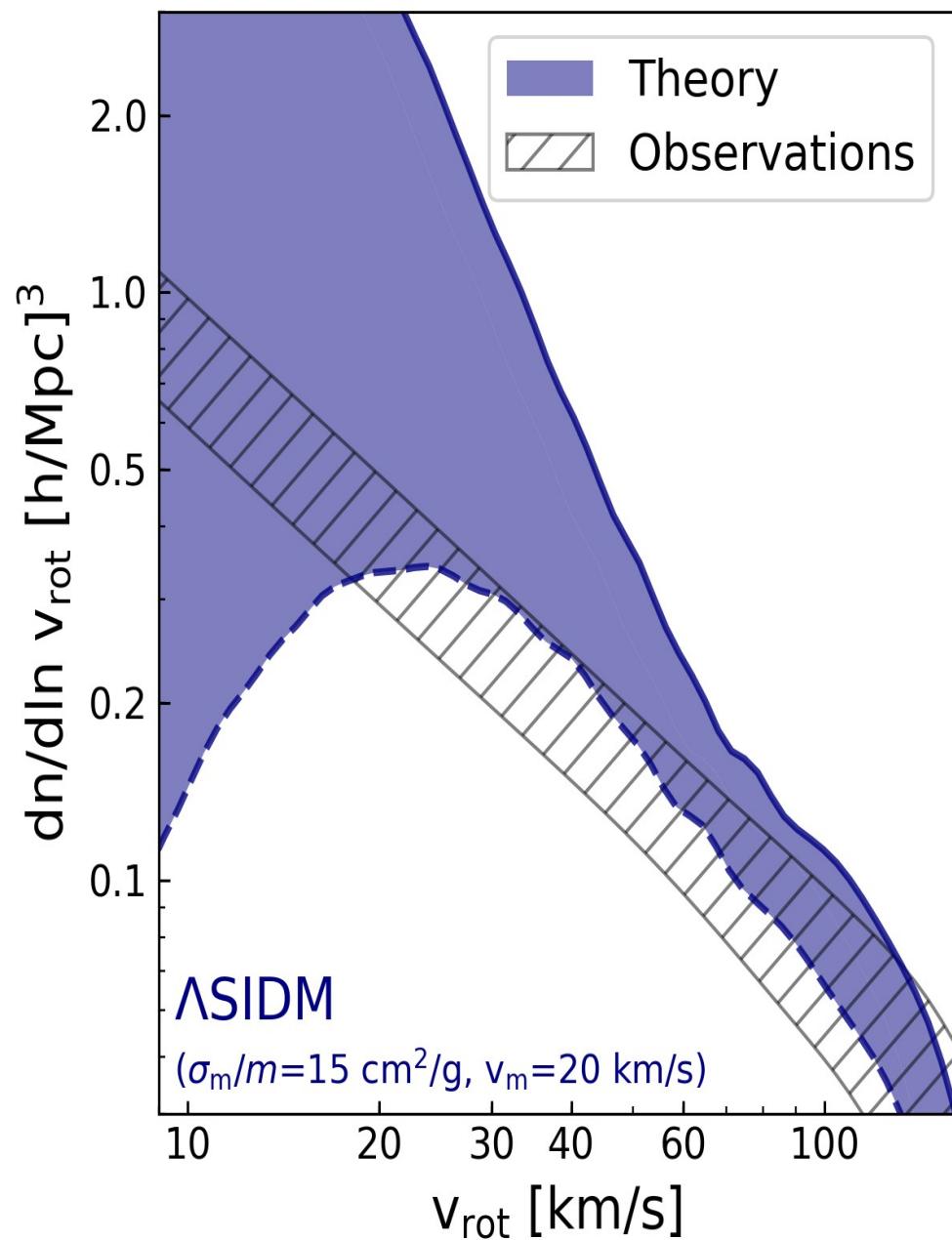
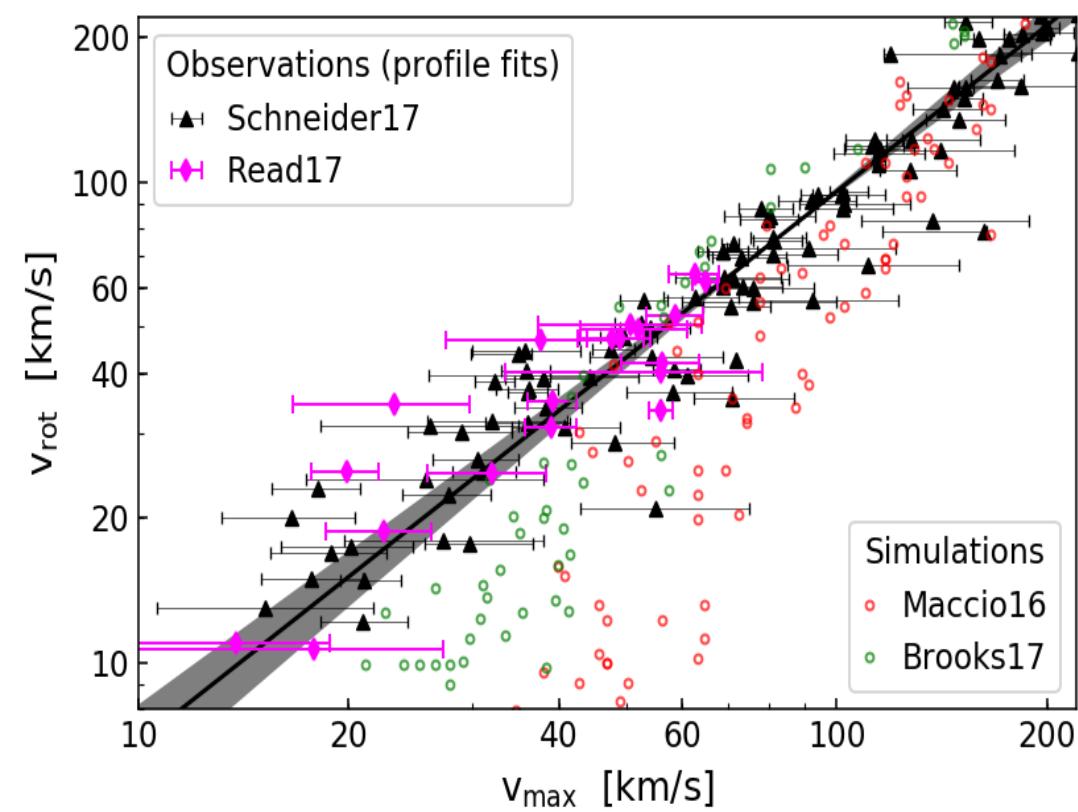
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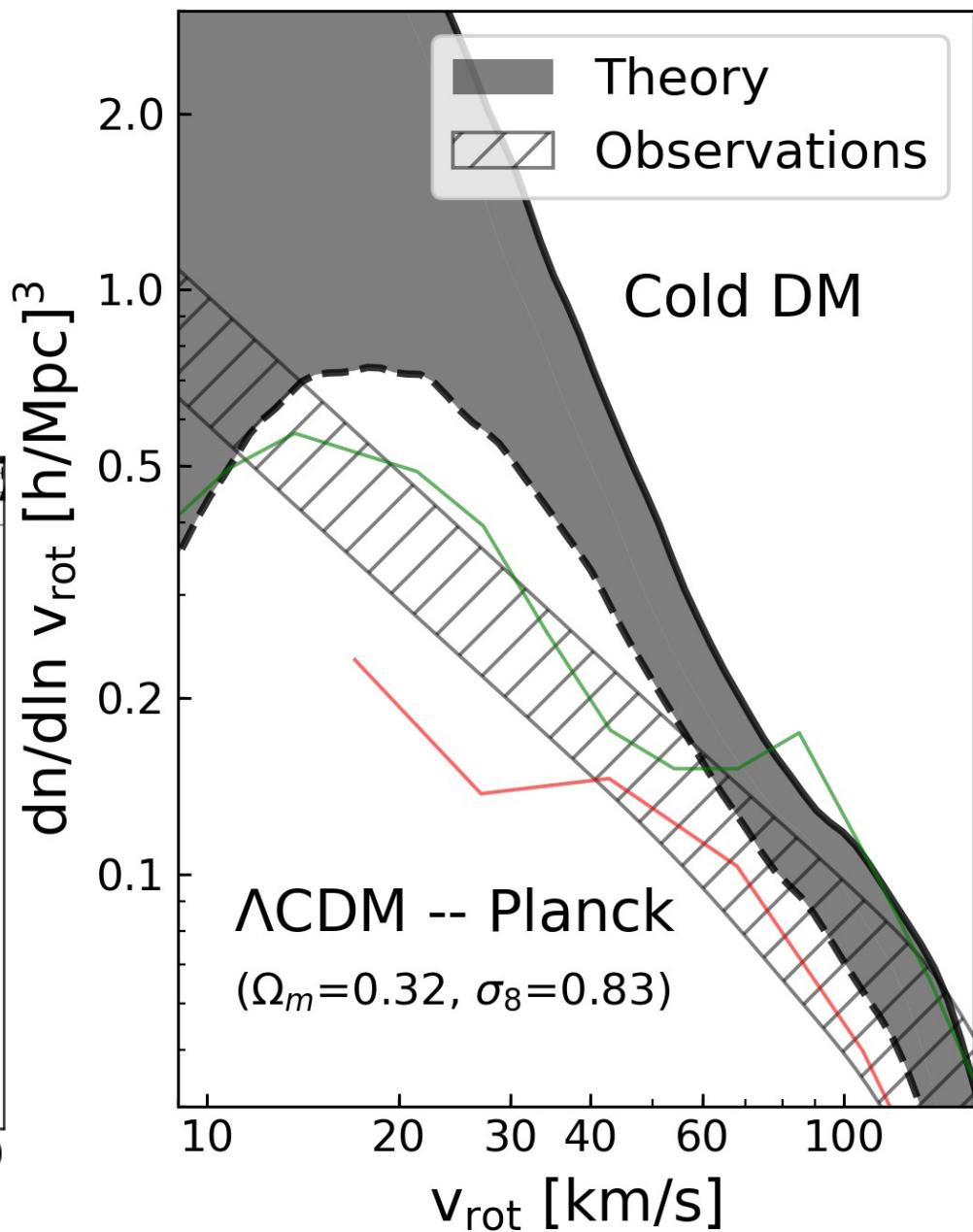
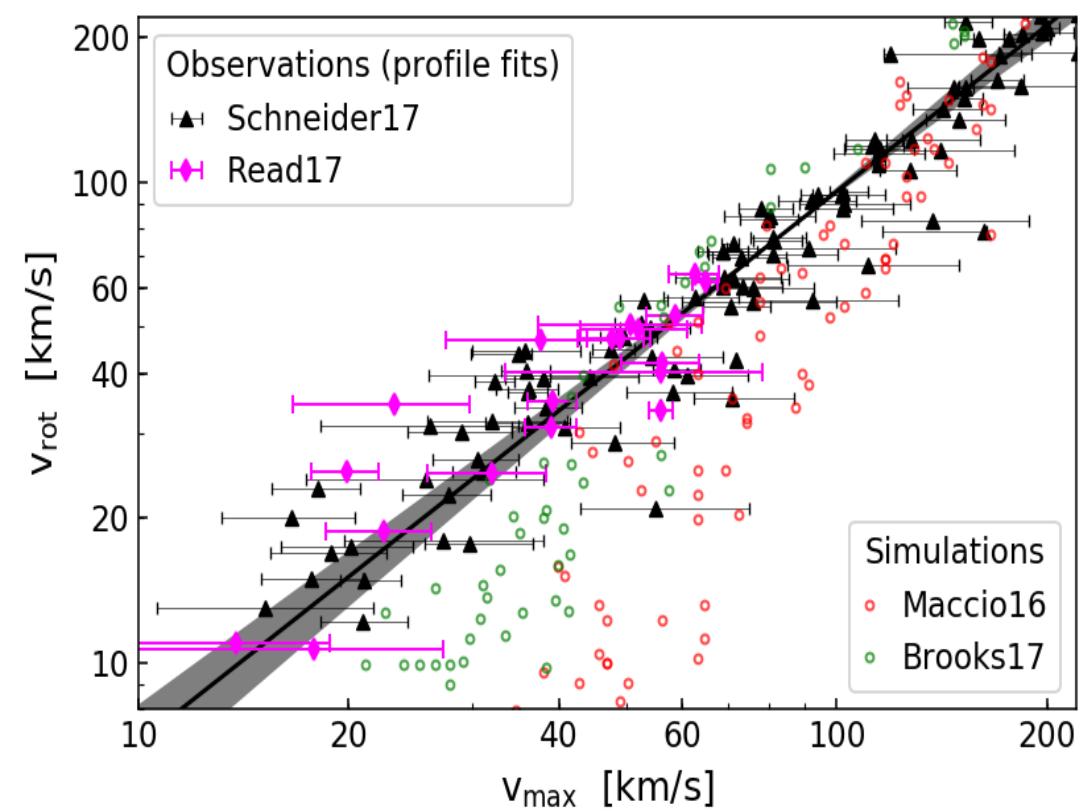
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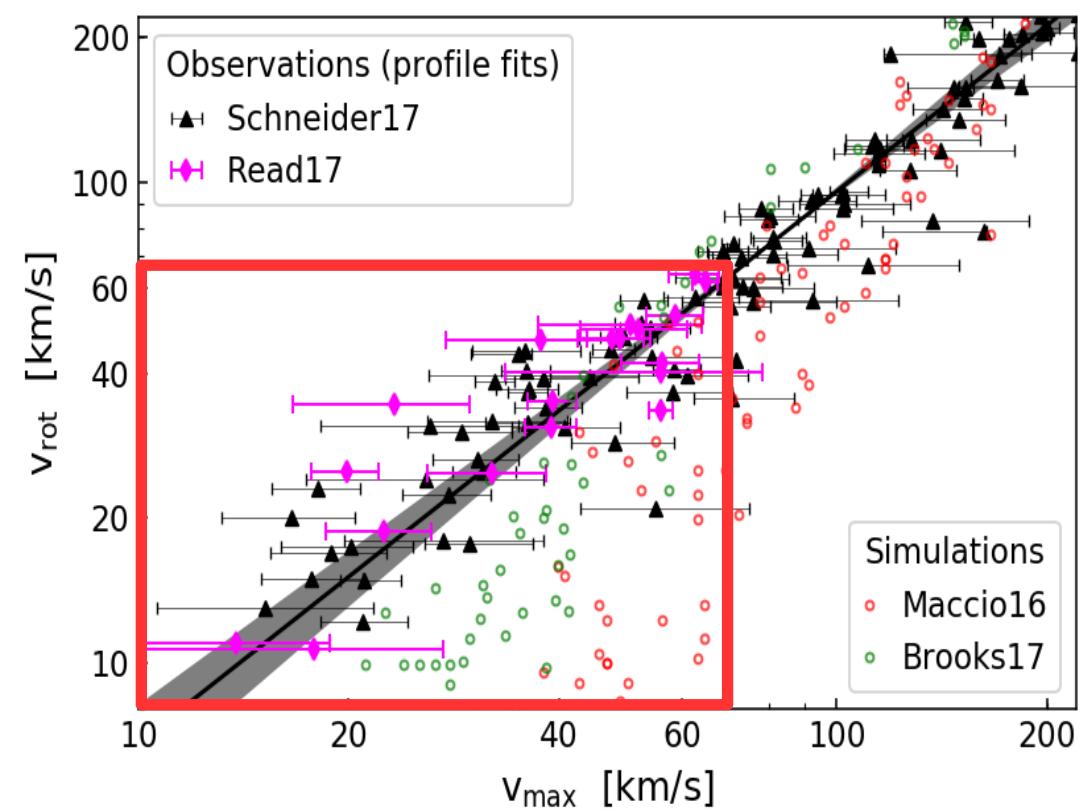
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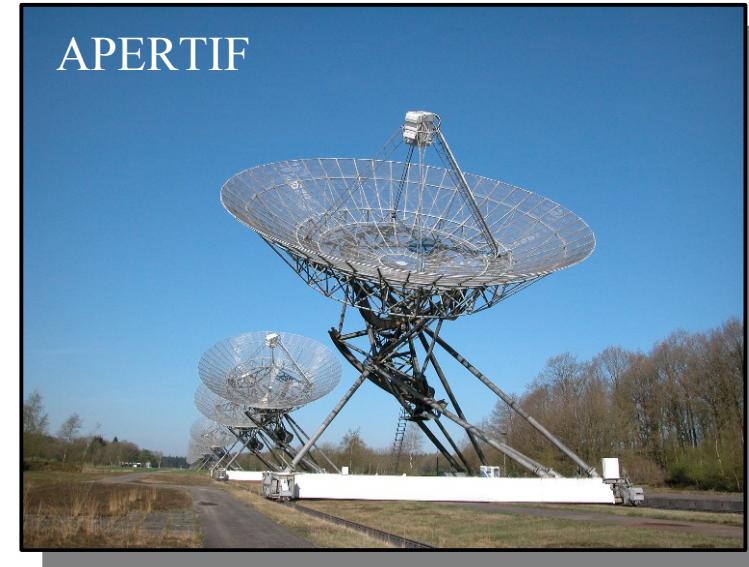
Dwarf galaxies in the local universe

1000 – 2000 dwarfs
with resolved velocities

50 – 100 dwarfs with high-
res rotation curves



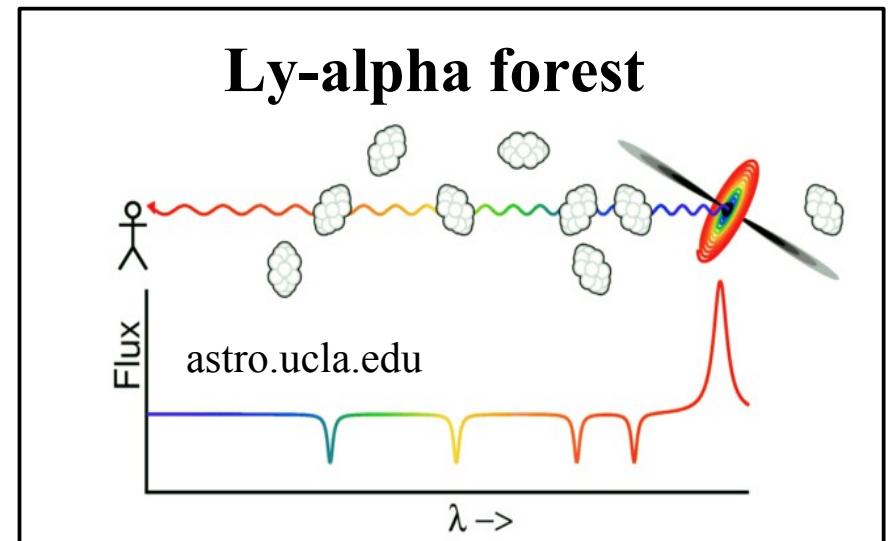
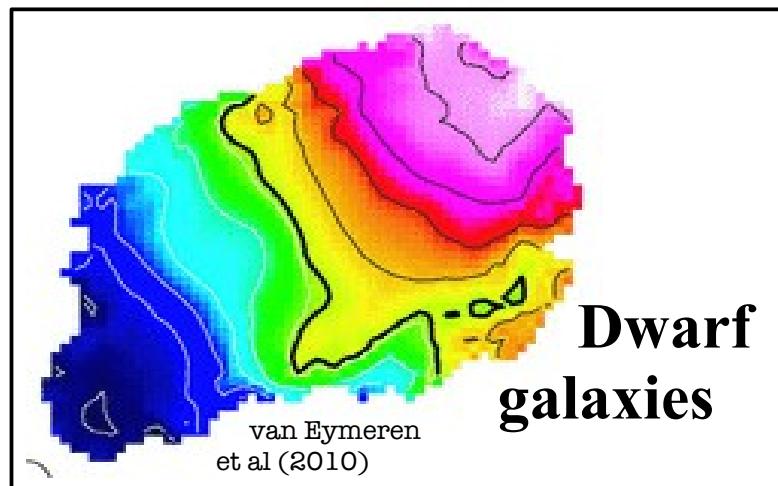
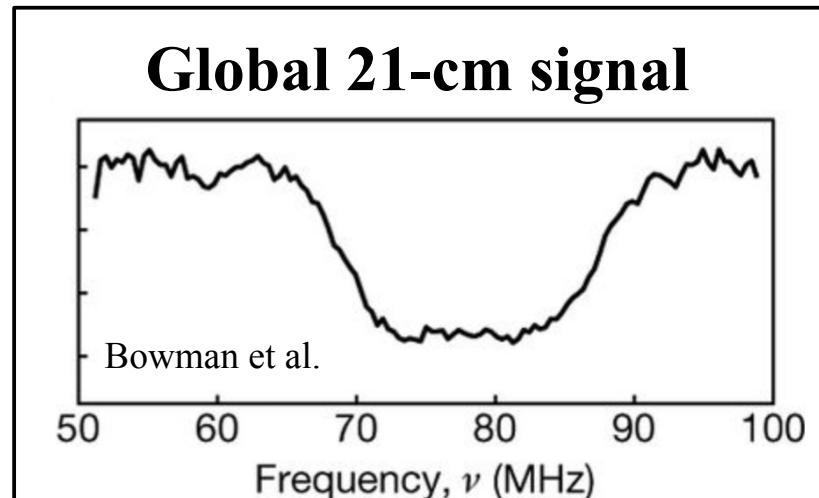
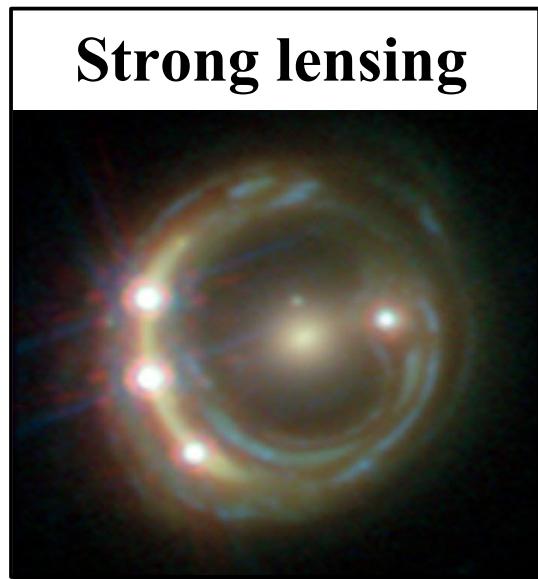
APERTIF



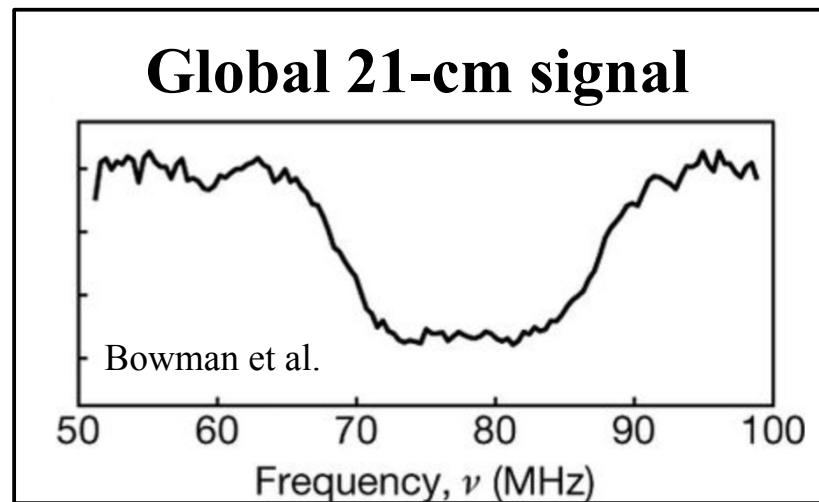
Wallaby



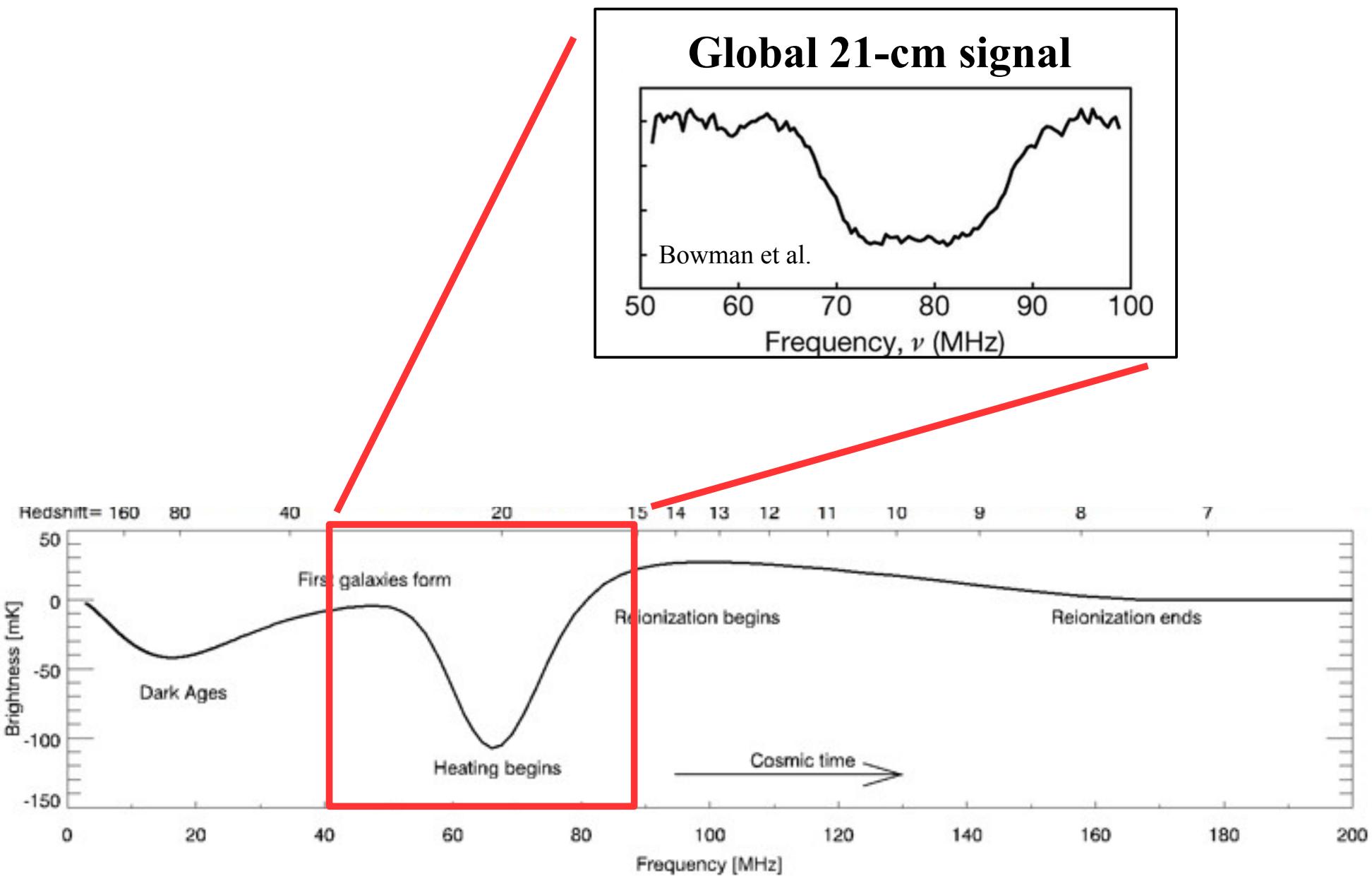
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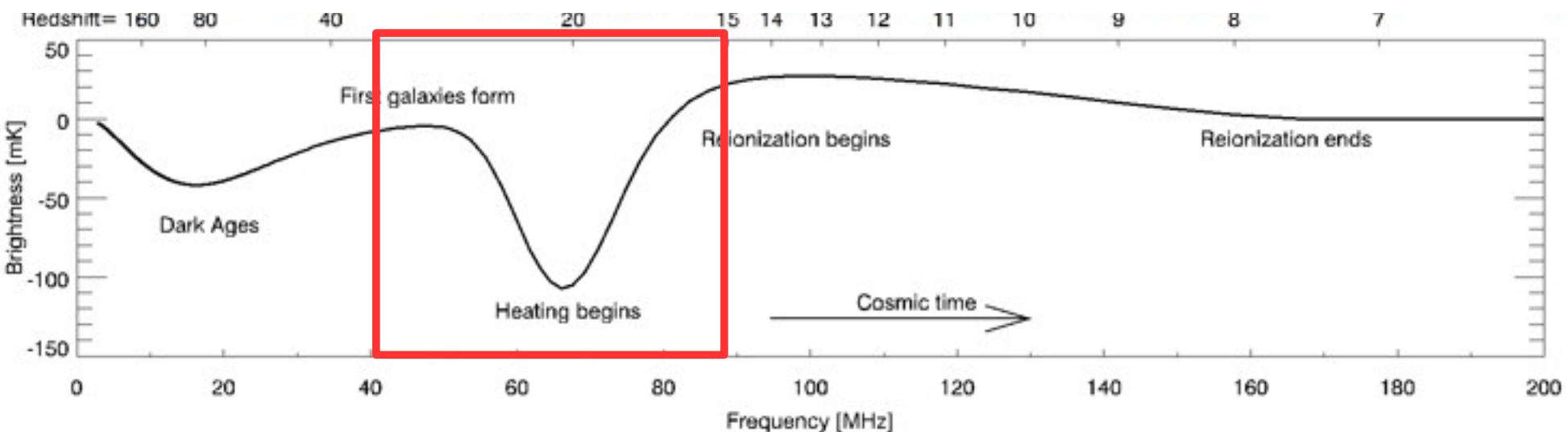
Global 21-cm signal



Global 21-cm signal

$$\delta T_b \propto \frac{x_\alpha}{1+x_\alpha} \left(1 - \frac{T_{\text{rad}}}{T_{\text{gas}}} \right)$$

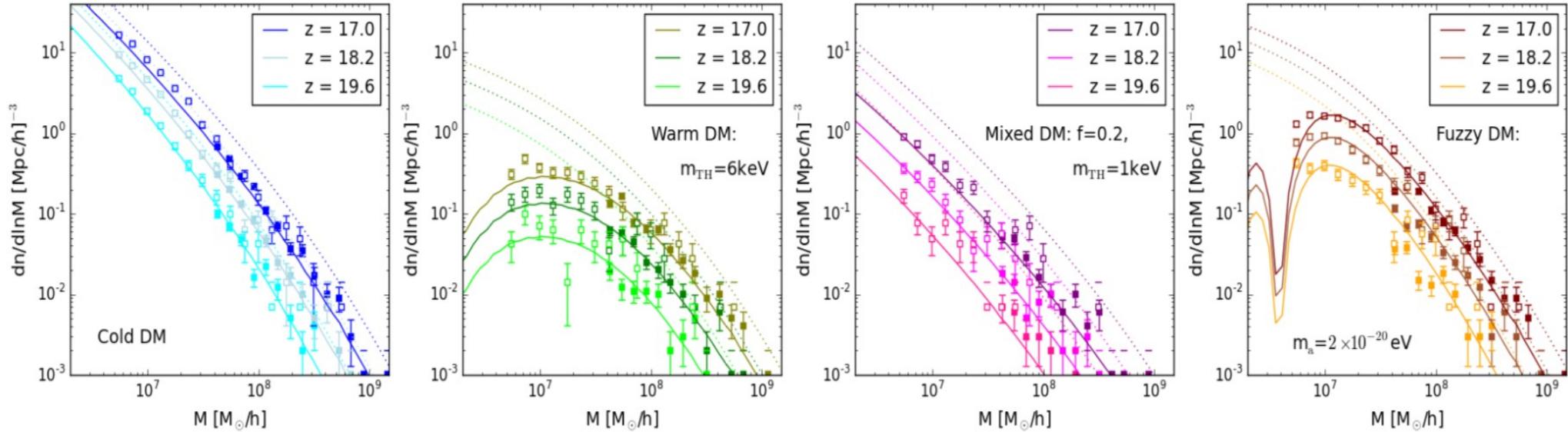
$$x_\alpha \propto \frac{d}{dt} \int dM f_*(M) \frac{dn}{d \ln M}$$



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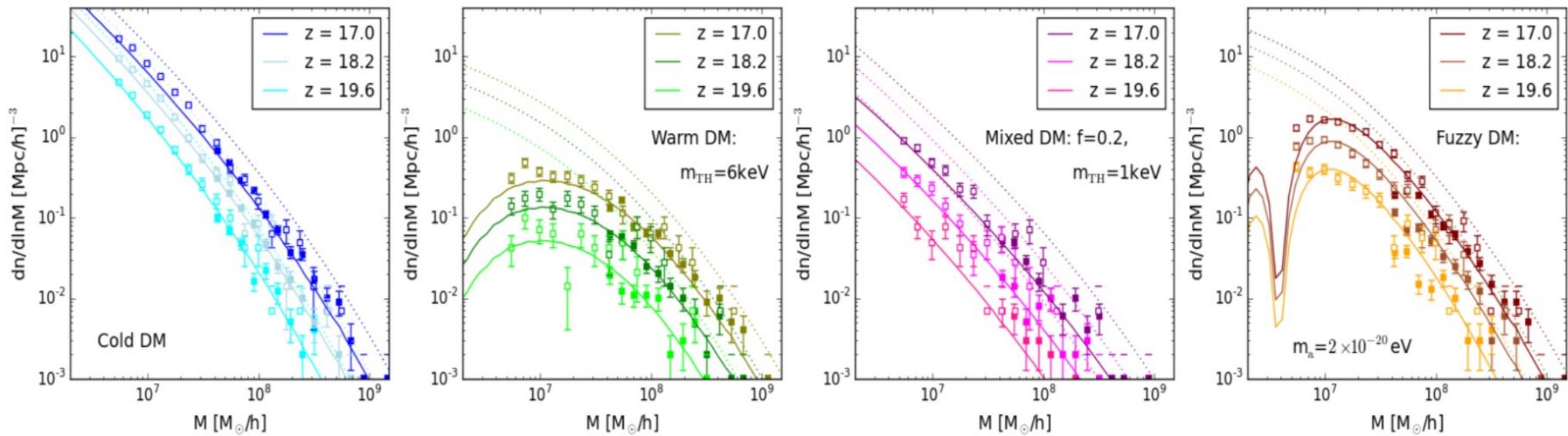


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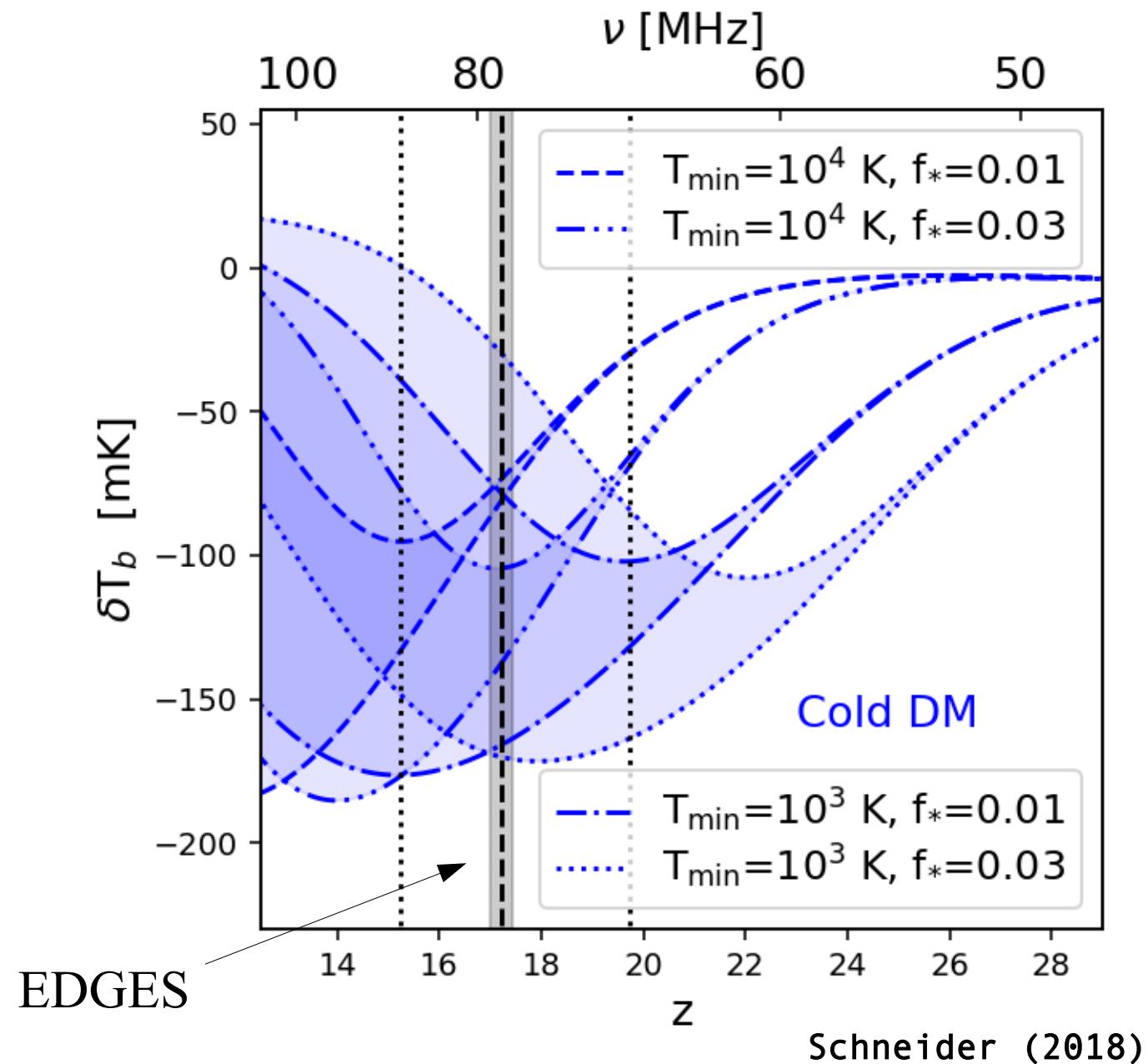
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< 3 percent (constant)



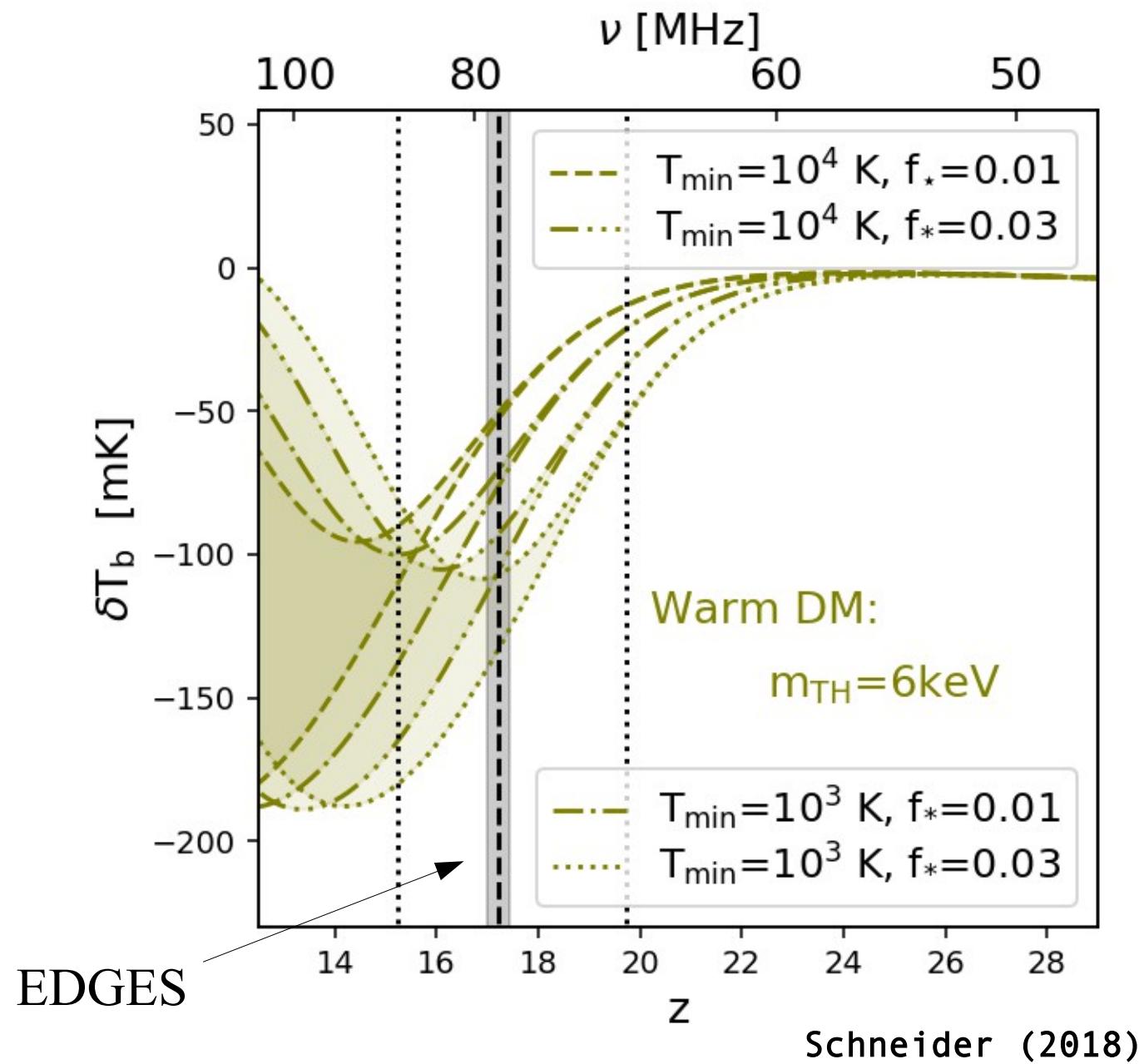
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Using ARES
(Jordan Mirocha)



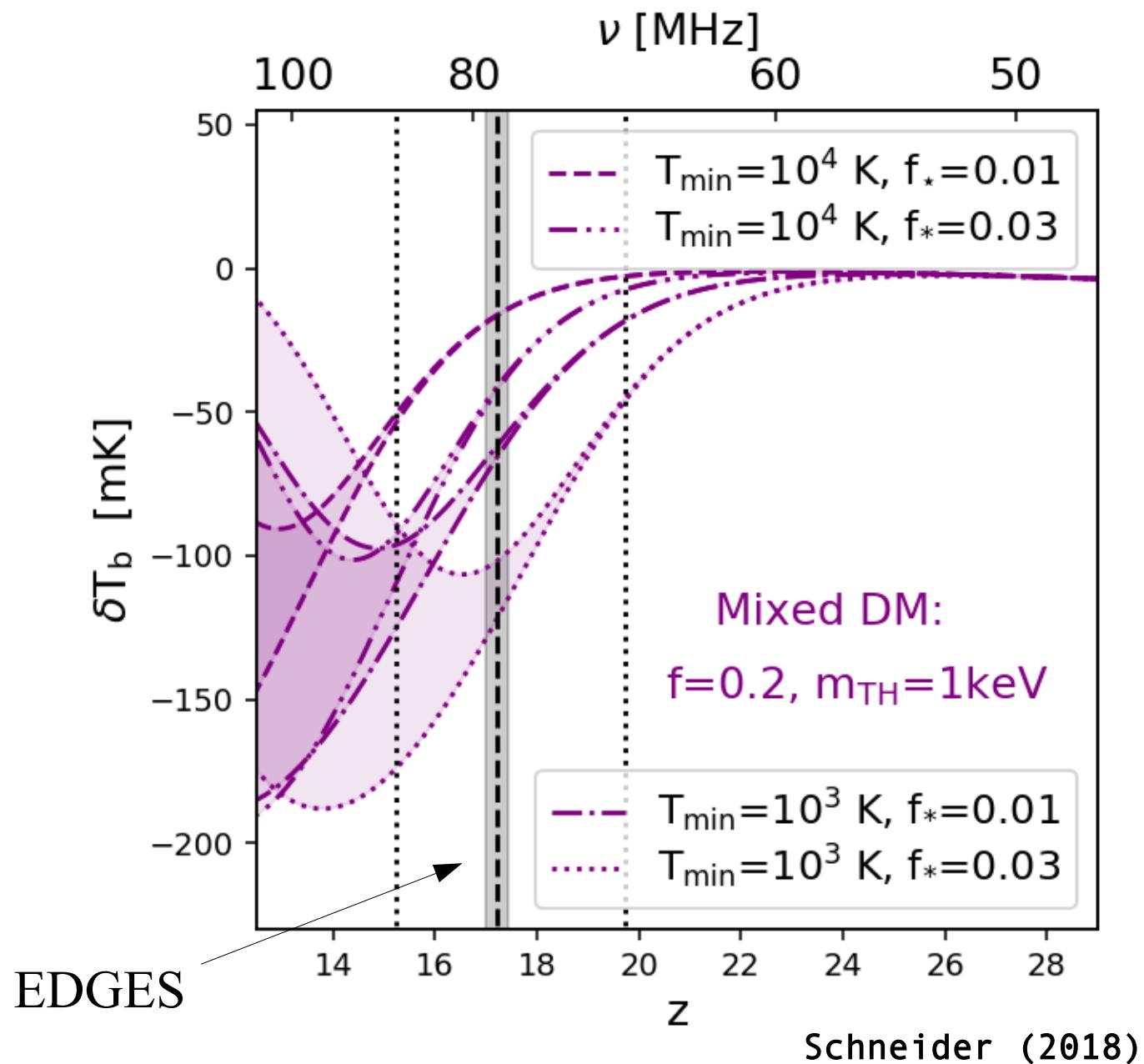
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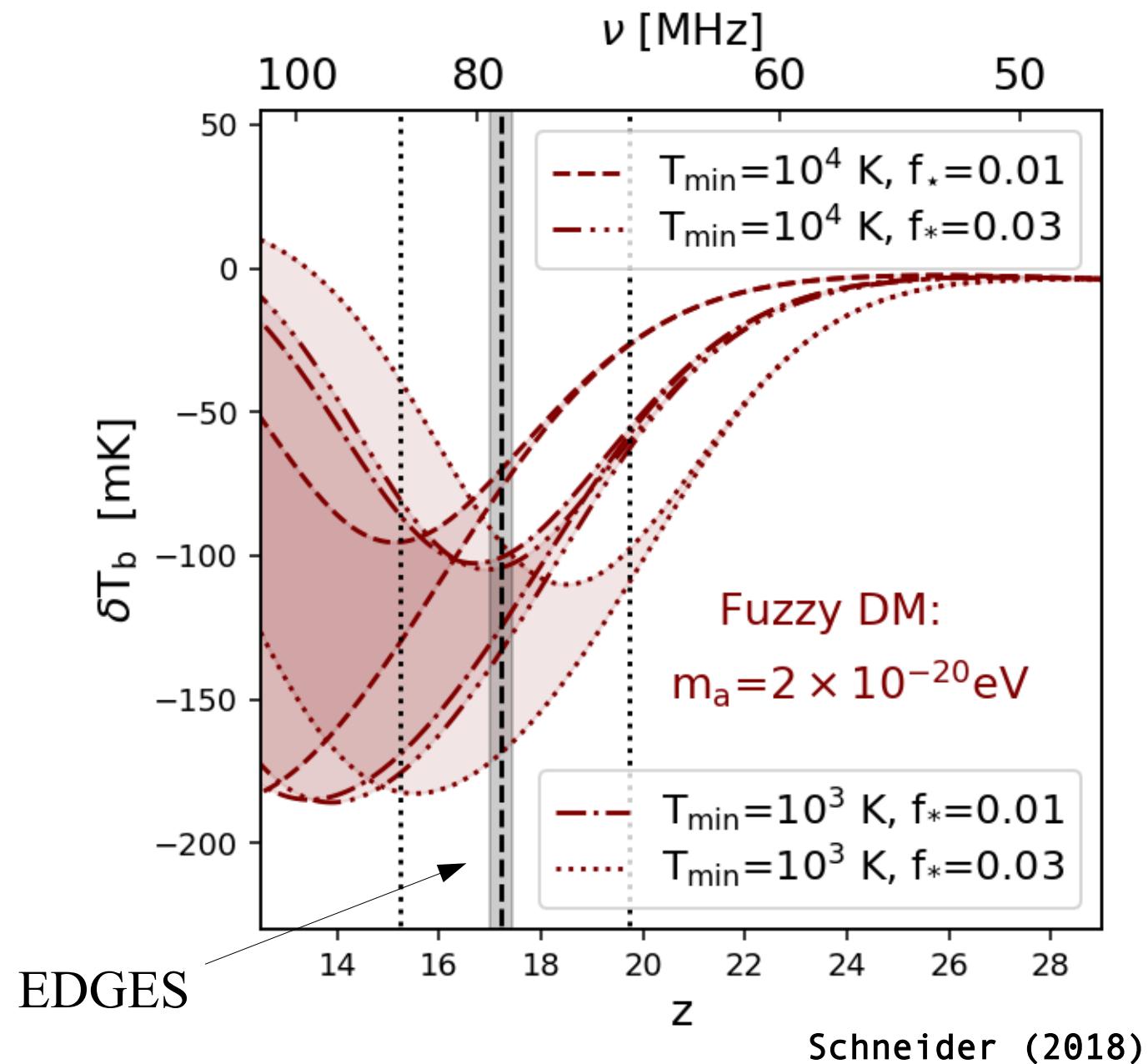
Global 21-cm signal

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(Jordan Mirocha)



Global 21-cm signal

Using ARES
(Jordan Mirocha)



Global 21-cm signal



PRIZM



LEDA



Global 21-cm signal



SKA



EDGES



SARAS 2



LEDA



PRIZM

Conclusion:

Structure formation is a powerful tool
to constrain (parts of the) DM parameter
space...

... and lots of new data is coming !