MIAPbP - 13/1/2025

Reconstructing the matter power spectrum with cosmic shear

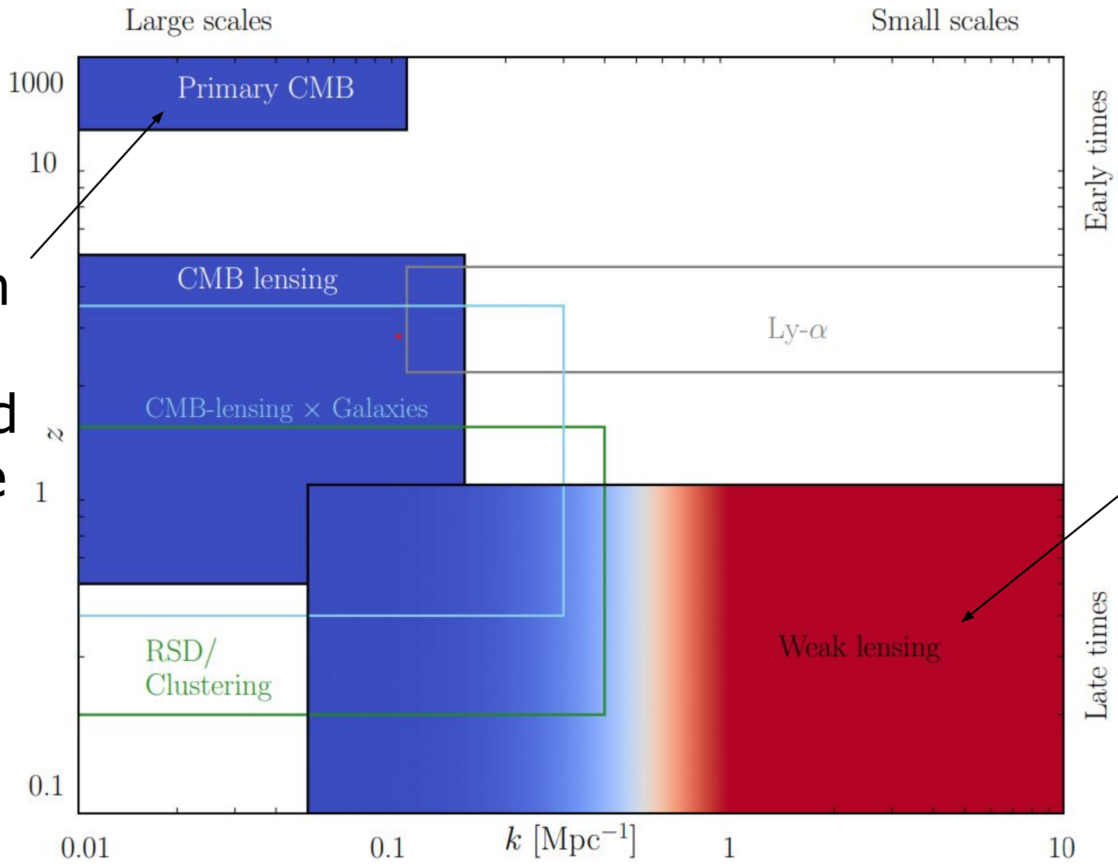
Calvin Preston

with Alexandra Amon, George Efstathiou & Keir Rogers

Presenting work from: [2305.09827](), [2404.18240](), [2505.02233]()

Big picture

If we claim that we understand LCDM here …



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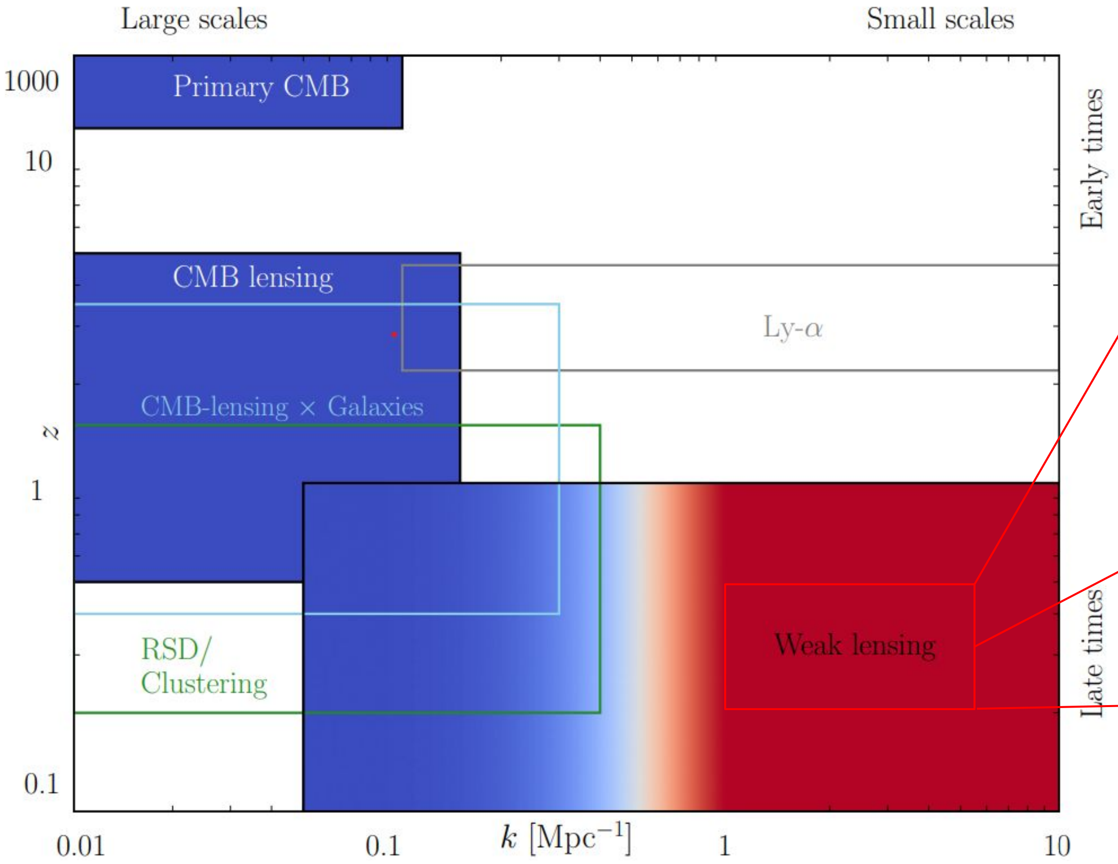
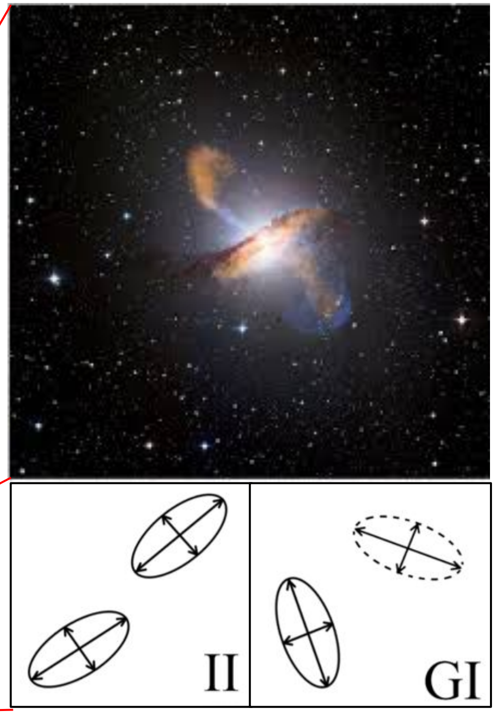
… can we understand physics and cosmology here?

Small scale modelling required





Small scales from weak lensing

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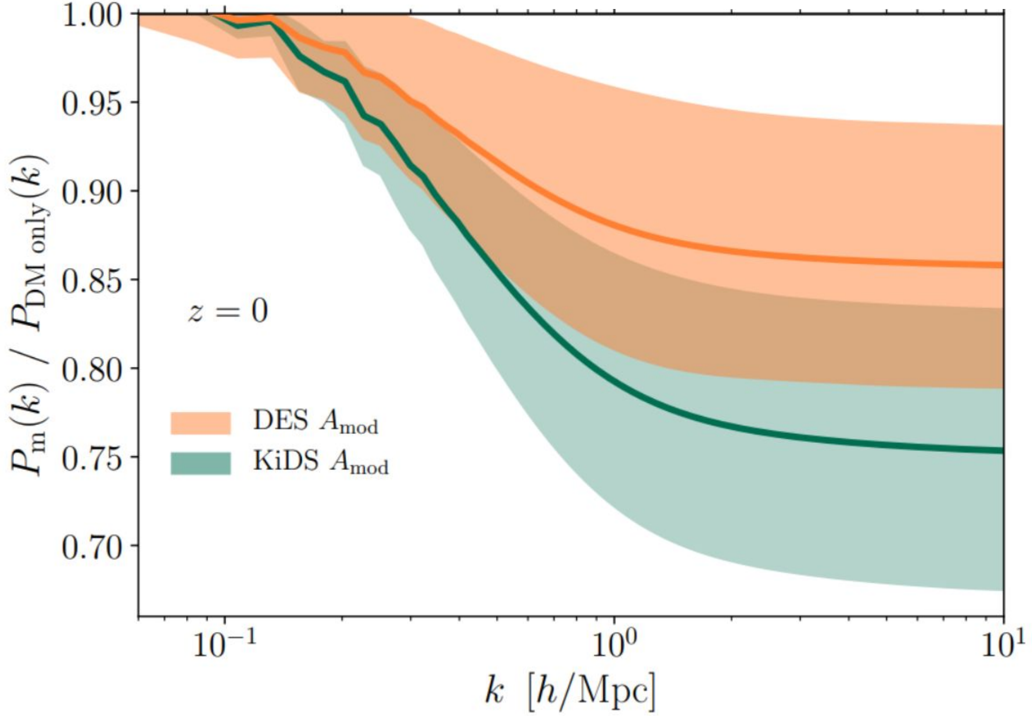
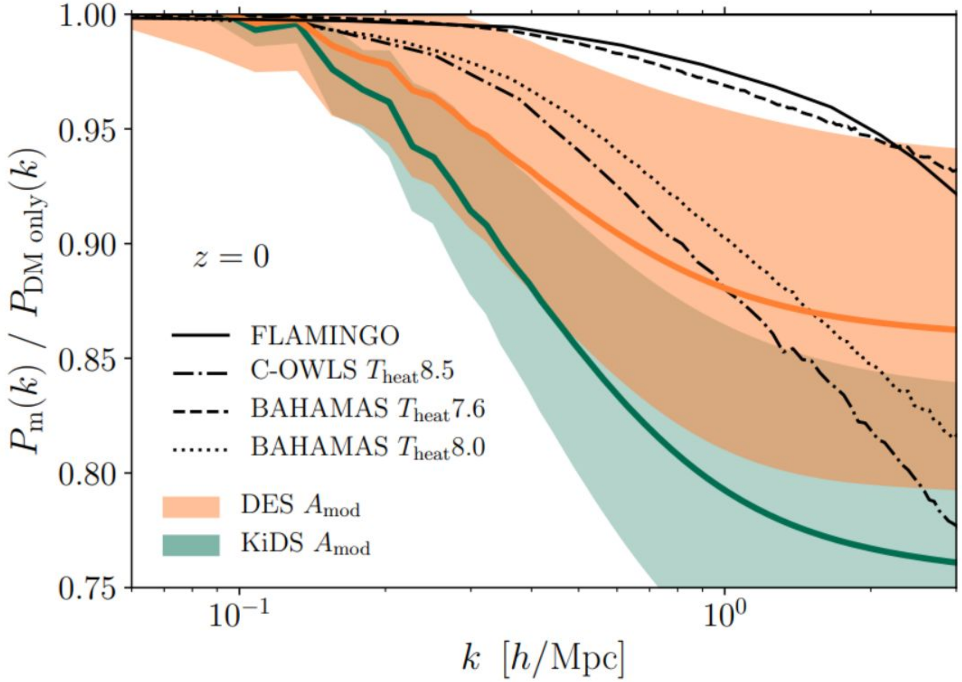


Suppression of the matter power spectrum conditioned on KiDS and DES data

What might suppress the matter power spectrum?

Obvious candidate is baryonic feedback

Ejection of gas by AGN and supernovae feedback processes to may times the virial radius



Leah Bigwood

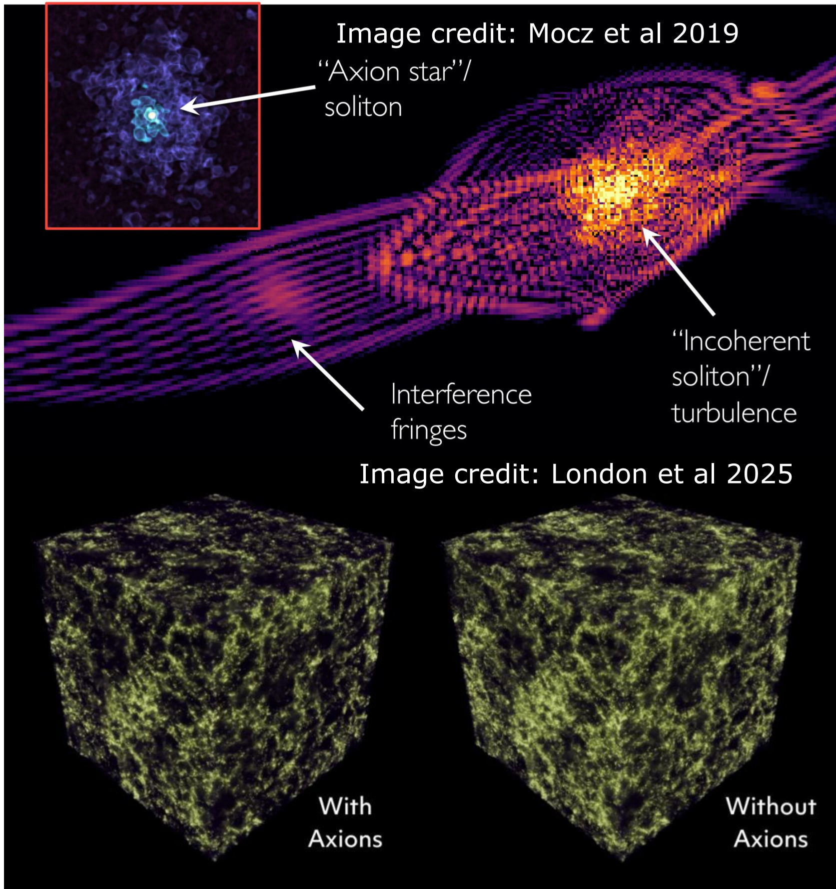
Jared Siegel

See Leah and Jared’s talks for more details on weak lensing, baryons and feedback!

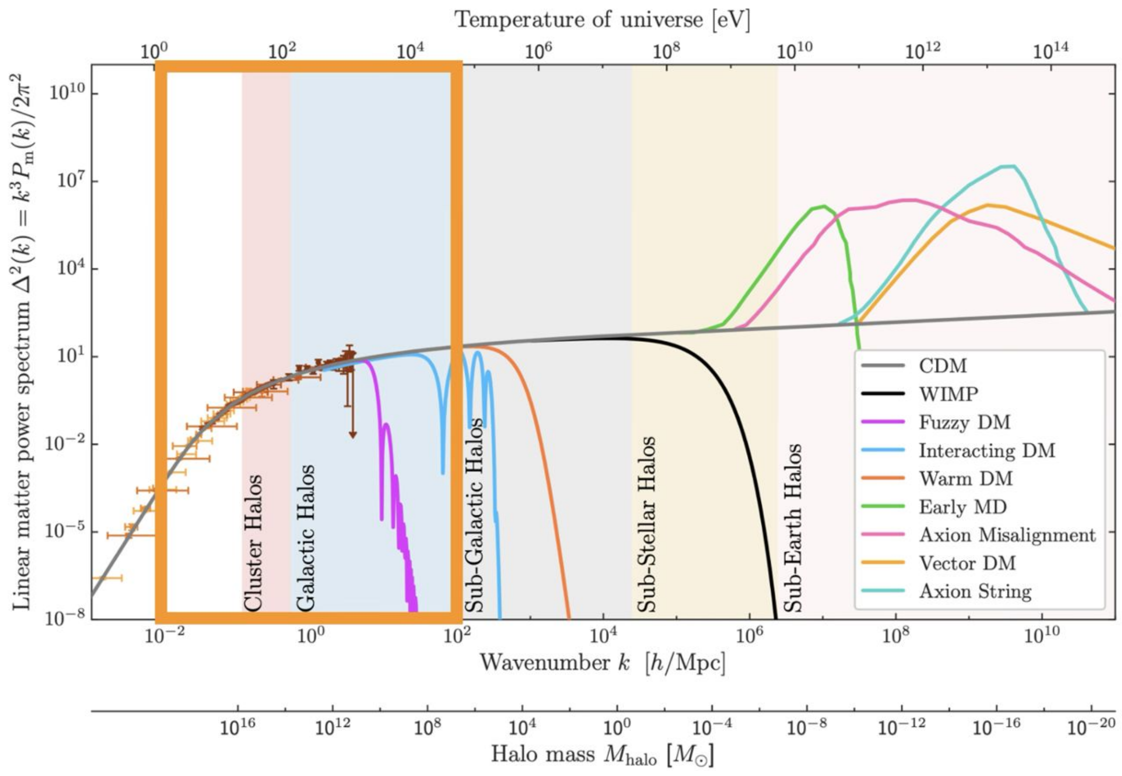
Beyond LCDM

Axions are theoretical particles with masses so small their wavelengths are comparable to galactic length scales

This can lead to suppression of power on scales set by the axion mass and fraction in simulations



Axions also suppress the power spectrum

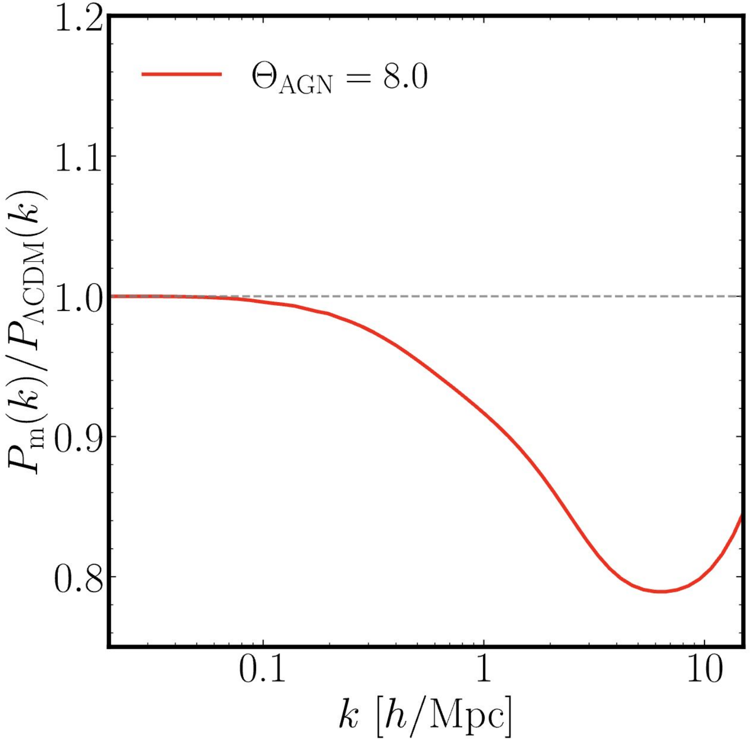


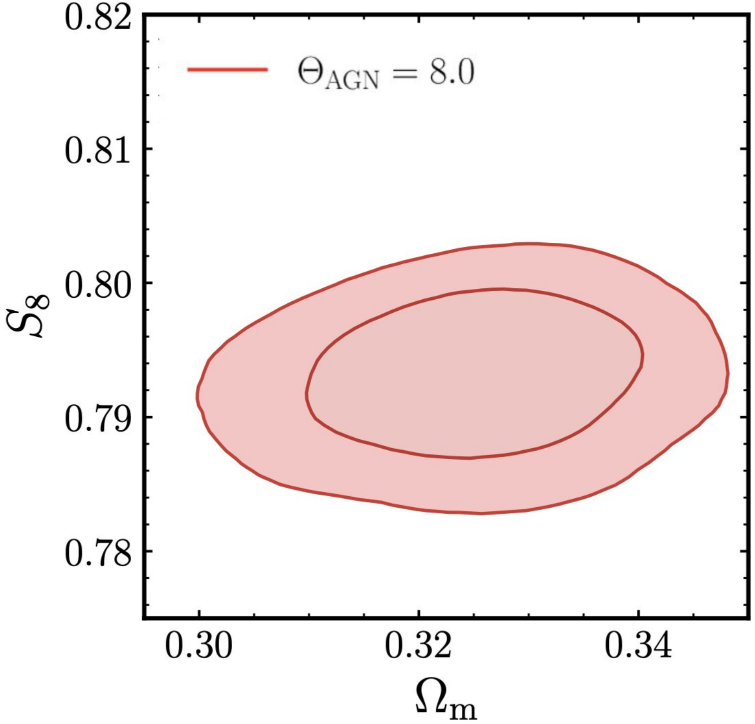
Weak lensing sees the scales axions might be suppress power on

Image credit: White paper on dark matter

Weak lensing and power suppression

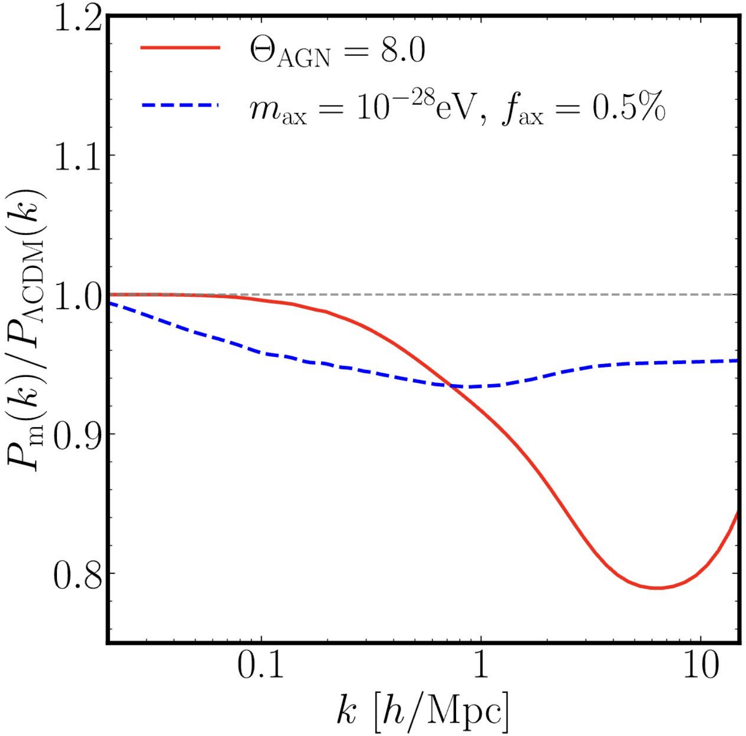
Marginalising over LCDM parameters with no small scale modelling

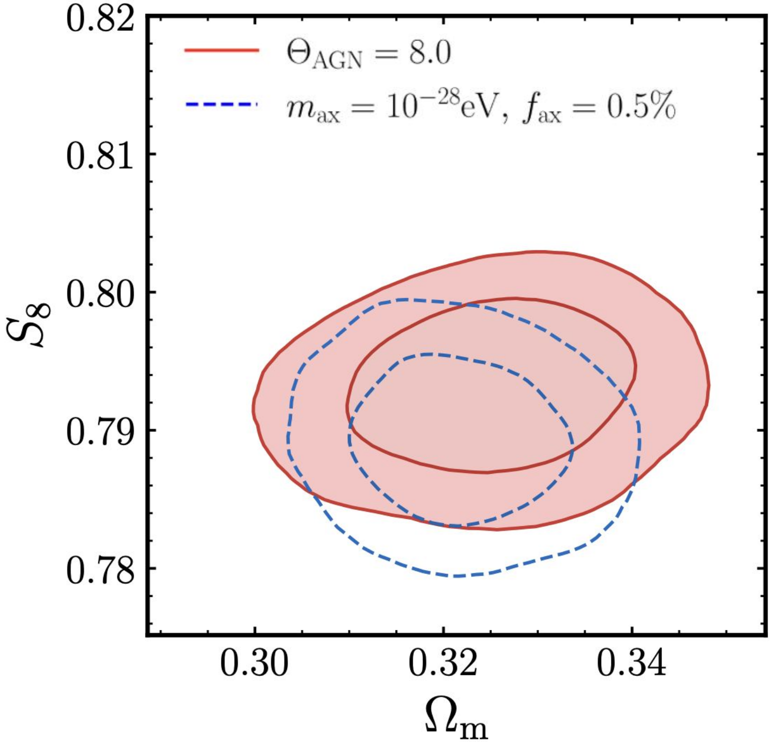




Weak lensing and power suppression

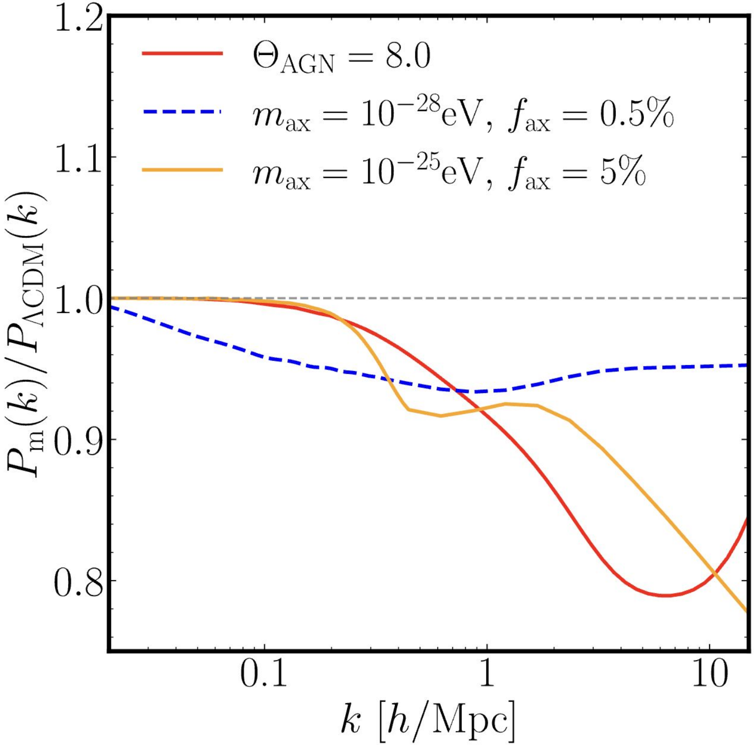
Marginalising over LCDM parameters with no small scale modelling

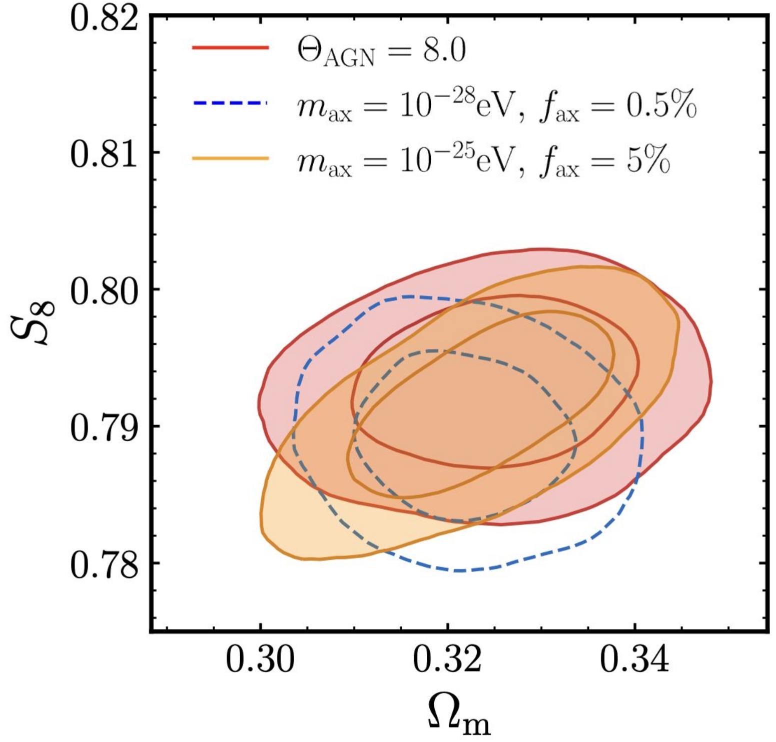




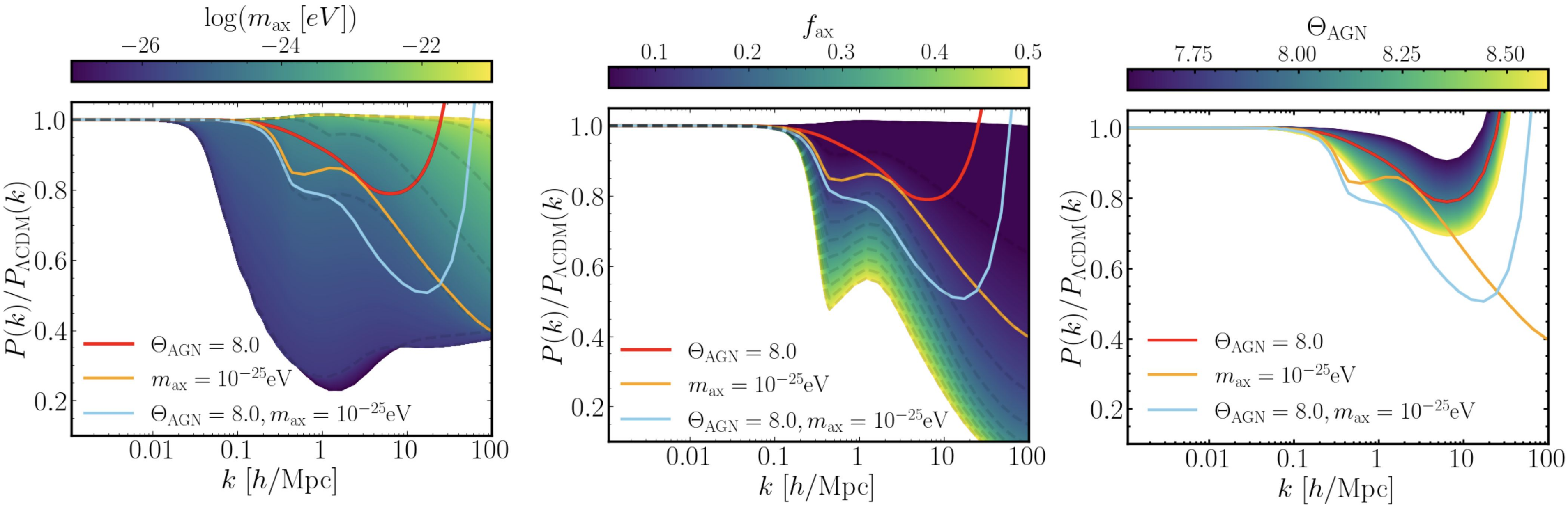
Weak lensing and power suppression

Marginalising over LCDM parameters with no small scale modelling





Axions ***and*** baryons: 3 “dials” for power suppression



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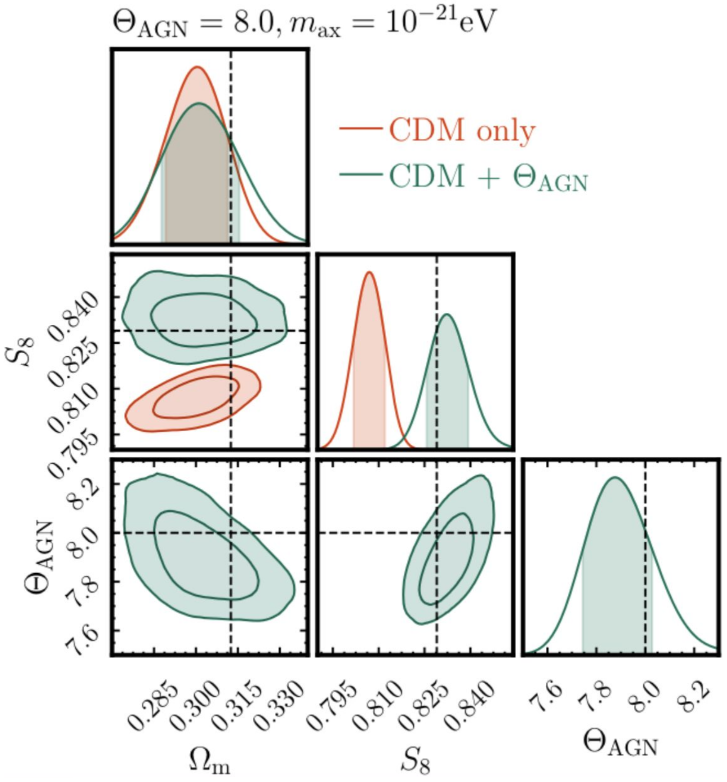
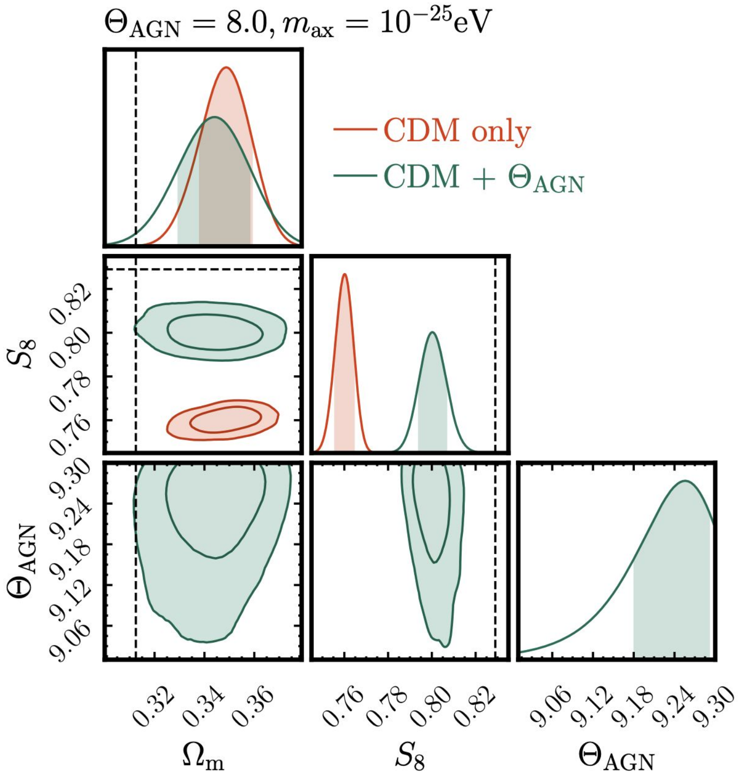
Extracting unbiased cosmology requires ***flexible*** small scale modelling





Marginalising over ***just*** baryons not flexible enough to capture true cosmology

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What is the most ***flexible*** thing we can do?

Measured power spectrum from cosmic shear

Power suppression bins we marginalised over

$$\frac{P_{\mathrm{m}}(k,z)}{P_{\mathrm{m}}^{\mathrm{DMO}}(k,z)} = \hat{\mathcal{P}}(k_i)$$

Fixed dark matter only power spectrum

Reconstructing the matter power spectrum

Reconstructing the matter power spectrum

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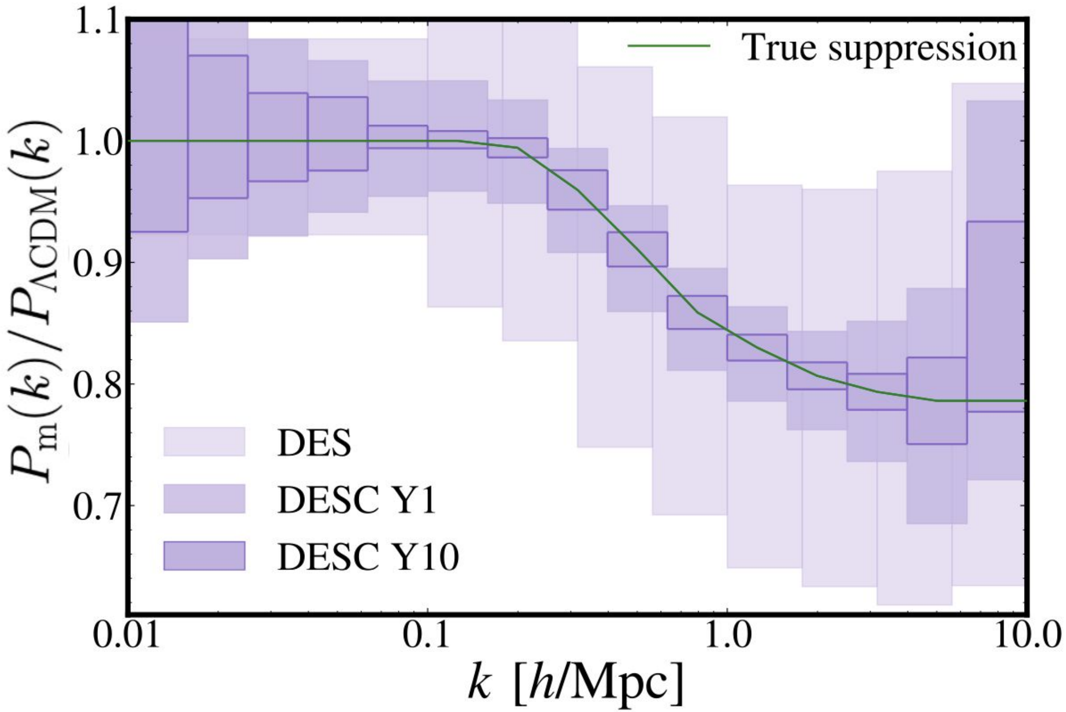

Power suppression constrained in wavenumber bins

Comparing current DES Y3 covariance with forecasted DESC Y1 and Y10 constraining power

Reconstructing the matter power spectrum

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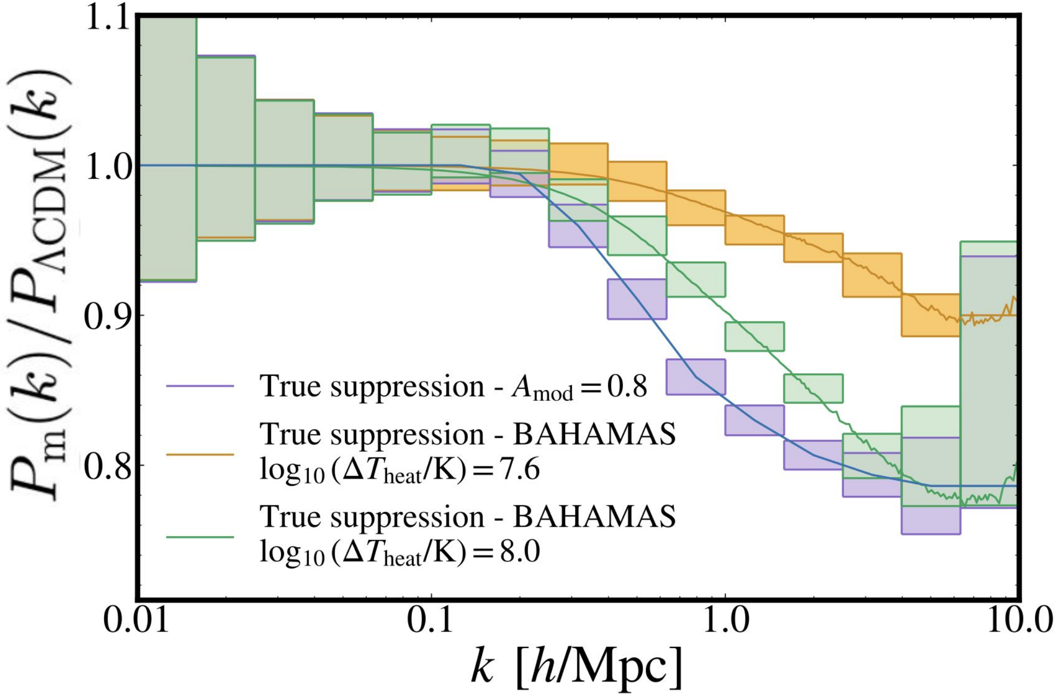
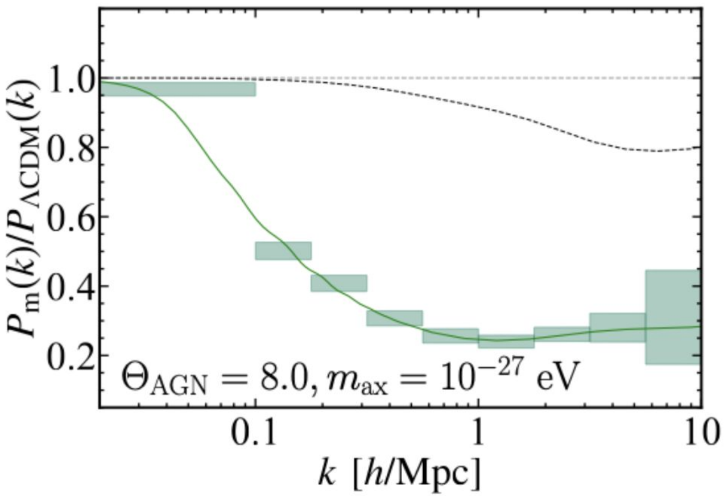


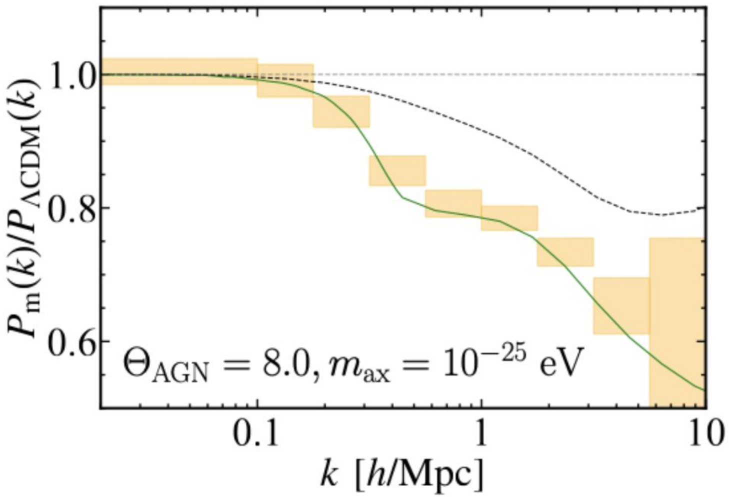
Reconstructing the spectrum sensitive to different feedback models

Cosmic shear then a ***test*** of different astrophysic models, rather than being ***reliant*** on them

Reconstructing the matter power spectrum

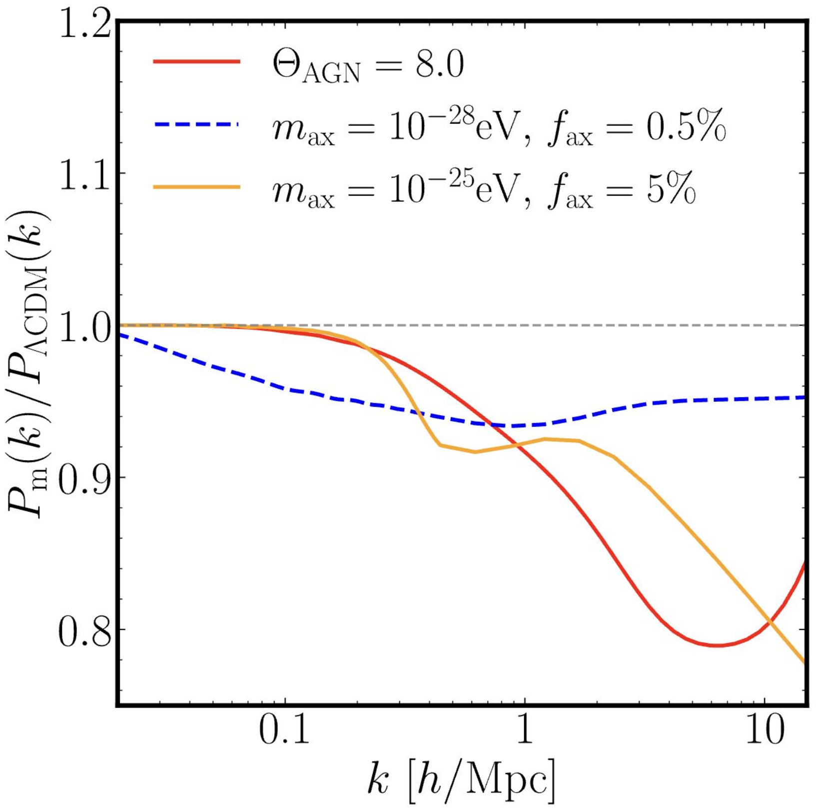


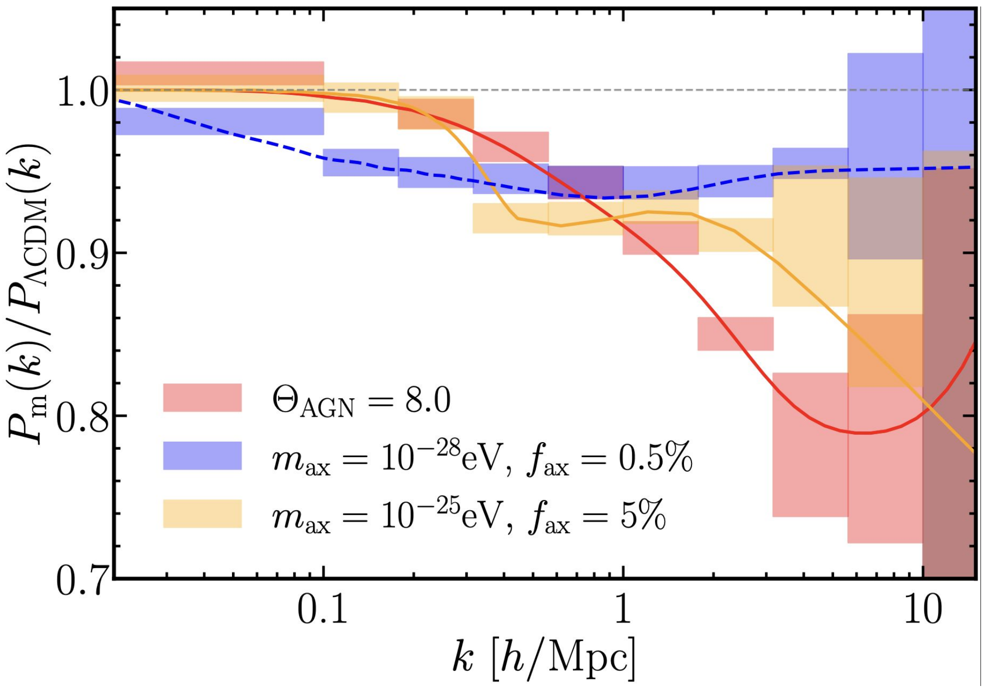
Reconstructions of matter power spectra with different small scale features



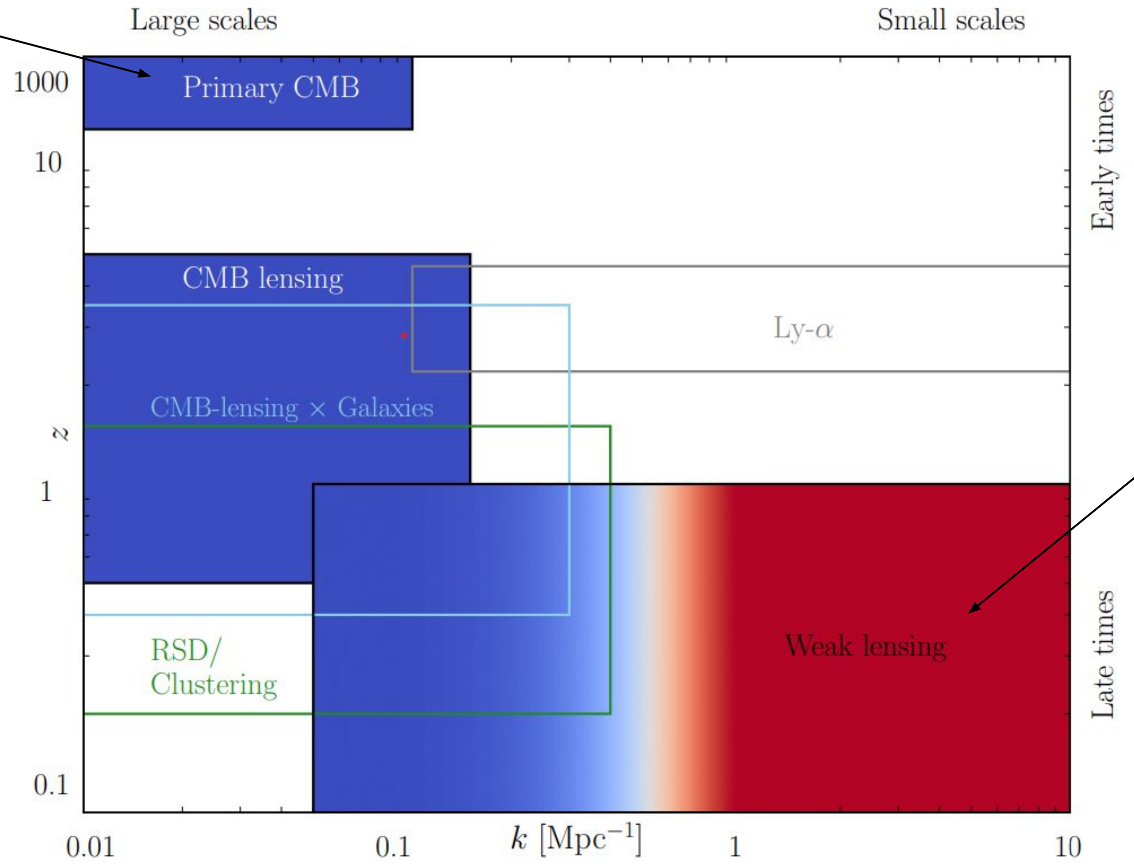
Such reconstructions can help to detect axions where baryonic feedback plays an important role

Distinguishing scenarios traditional weak lensing analyses cannot





Assuming LCDM understood here



Can we understand LCDM here?

Can we also test extensions to LCDM here?

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