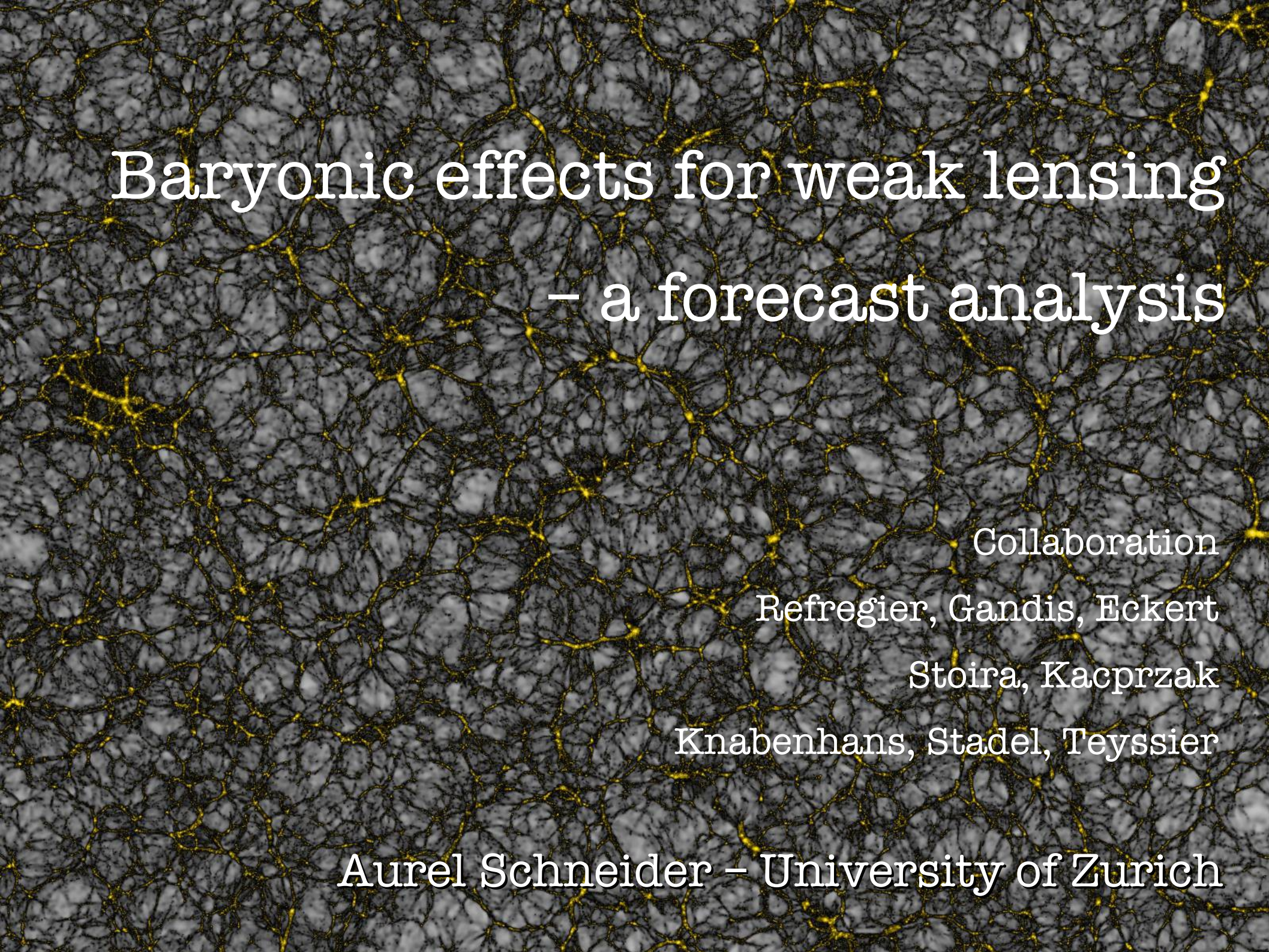


Baryonic effects for weak lensing – a forecast analysis

Collaboration

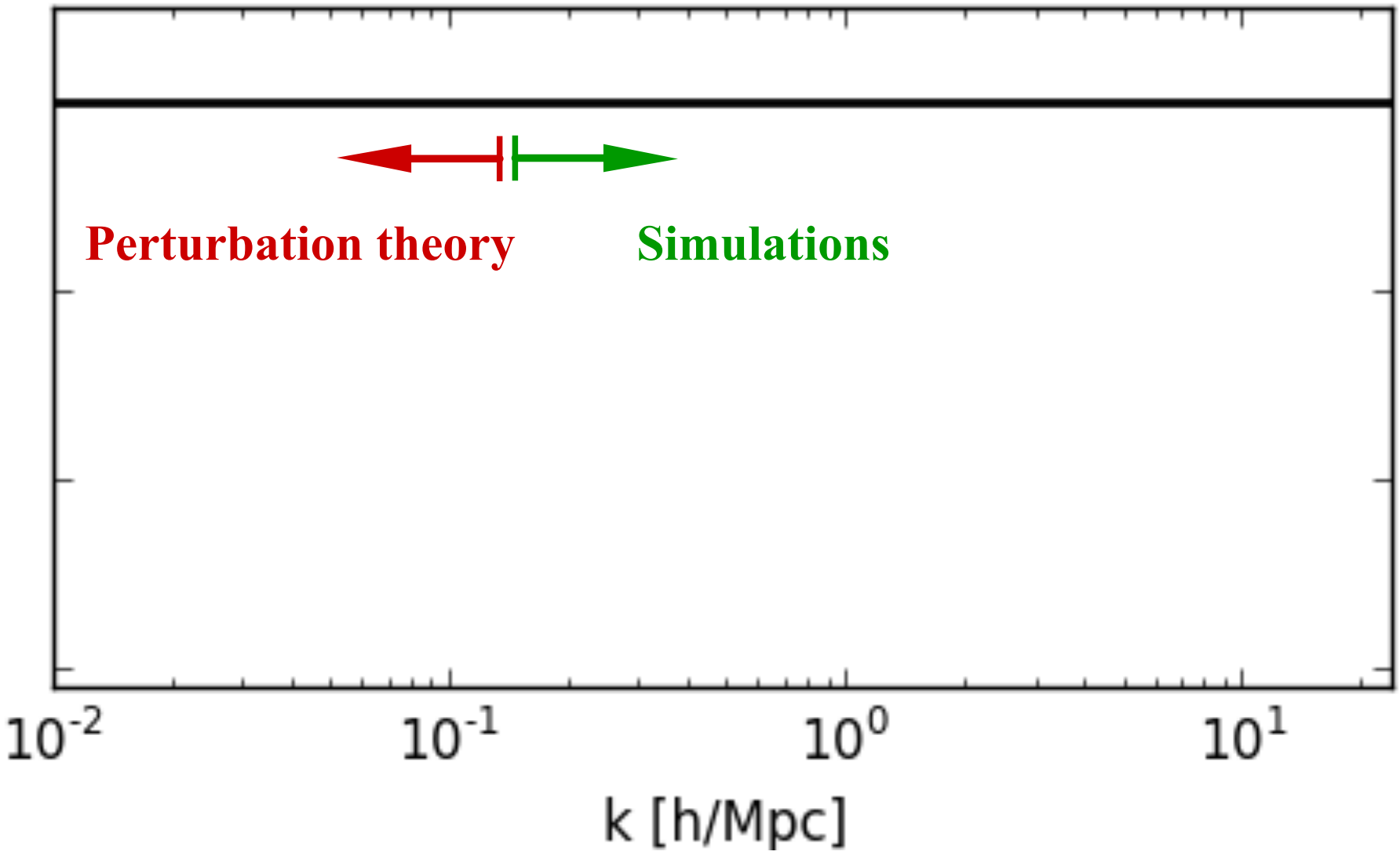
Refregier, Gandis, Eckert

Stoira, Kacprzak

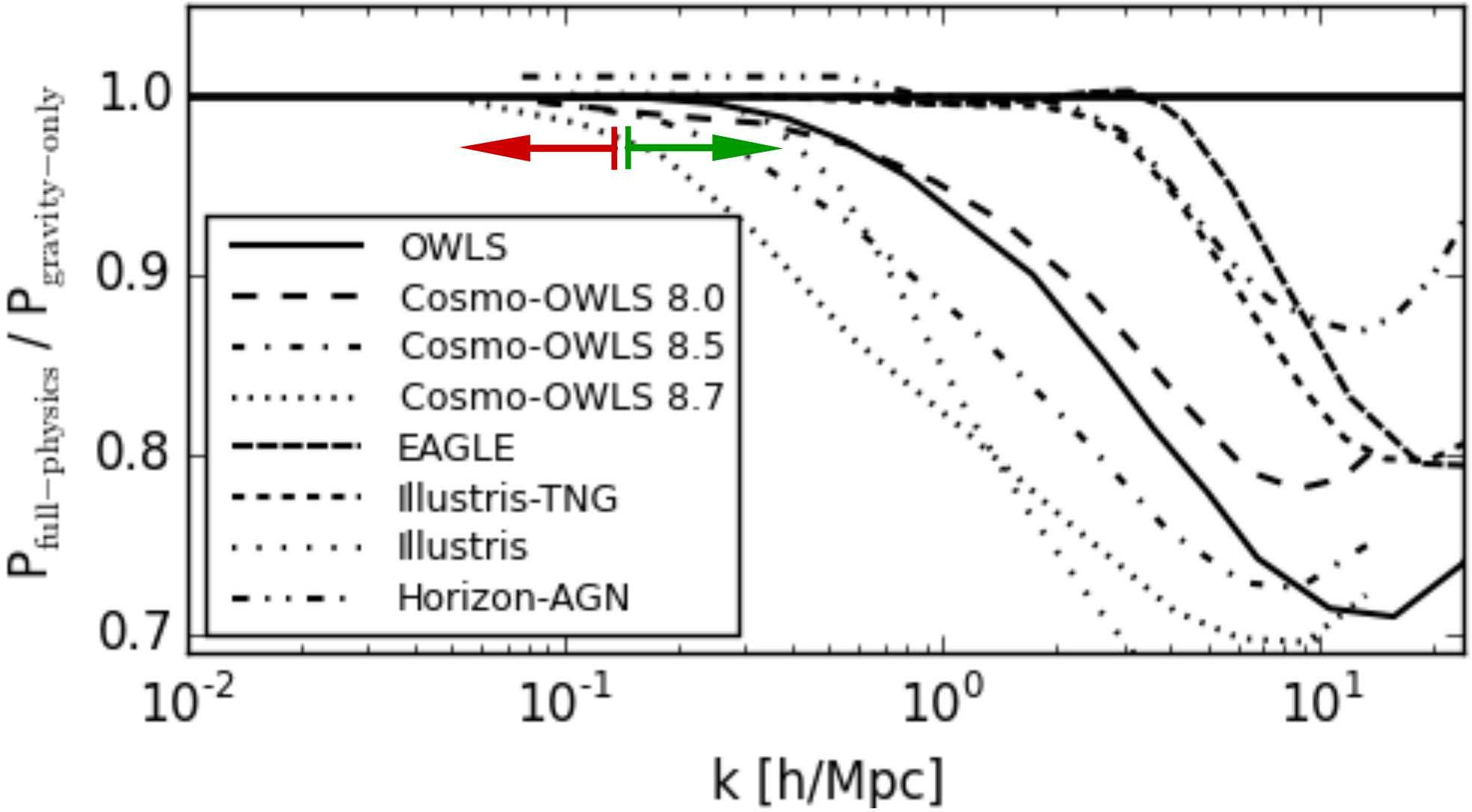
Knabenhans, Stadel, Teyssier

Aurel Schneider – University of Zurich

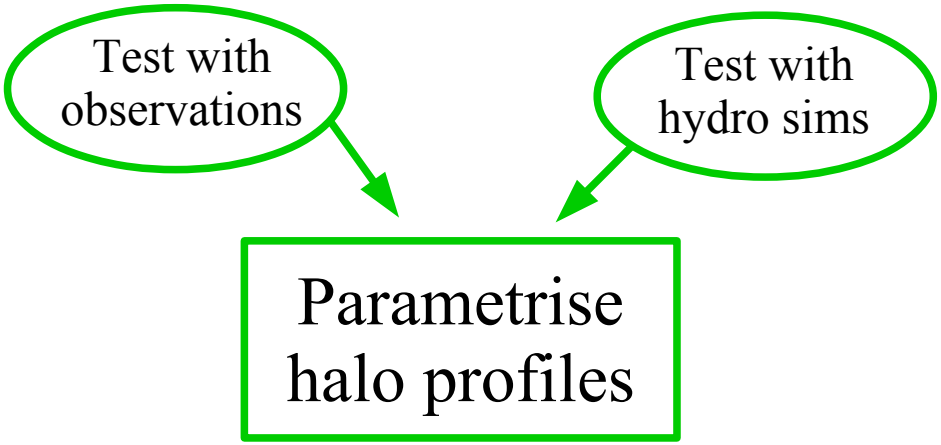
Motivation



Motivation


1.0
0.9
0.8
0.7
$P_{full-physics} / P_{gravity-only}$
OWLS
Cosmo-OWLS 8.0
Cosmo-OWLS 8.5
Cosmo-OWLS 8.7
EAGLE
Illustris-TNG
Illustris
Horizon-AGN
10^{-2}
10^{-1}
10^{0}
10^{1}
k [h/Mpc]

Baryonification Model



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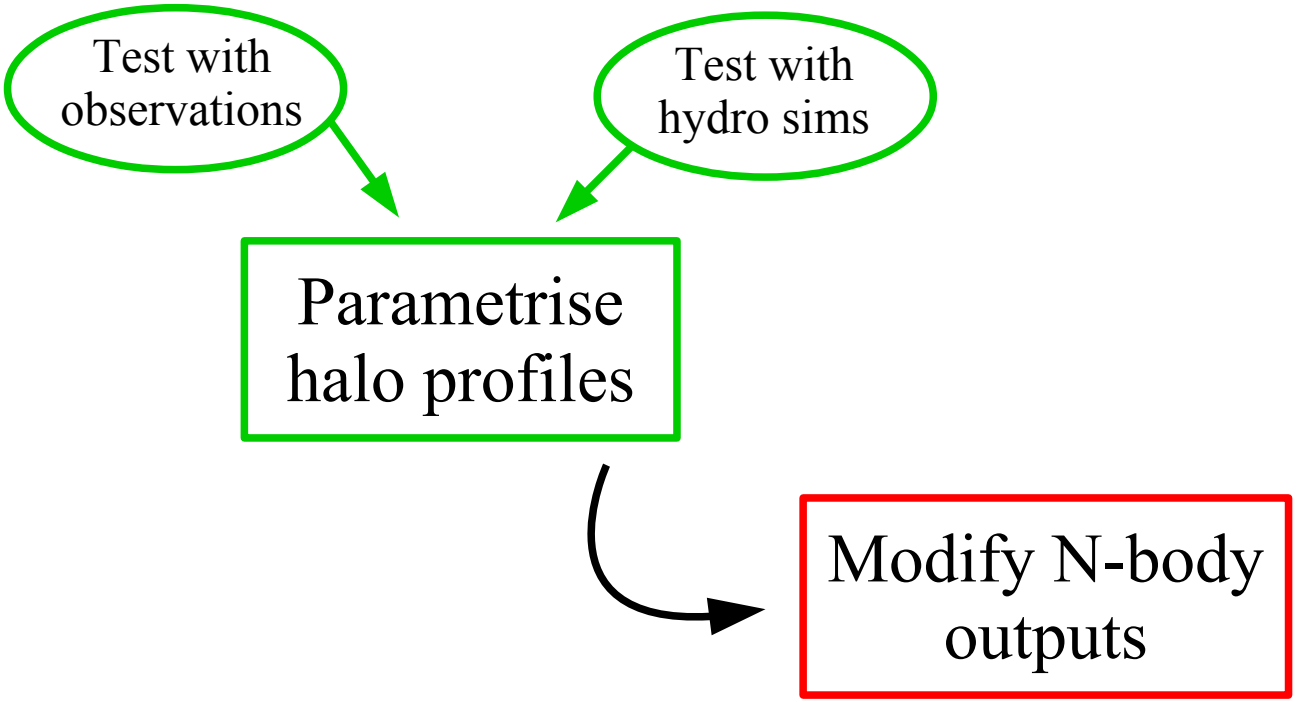

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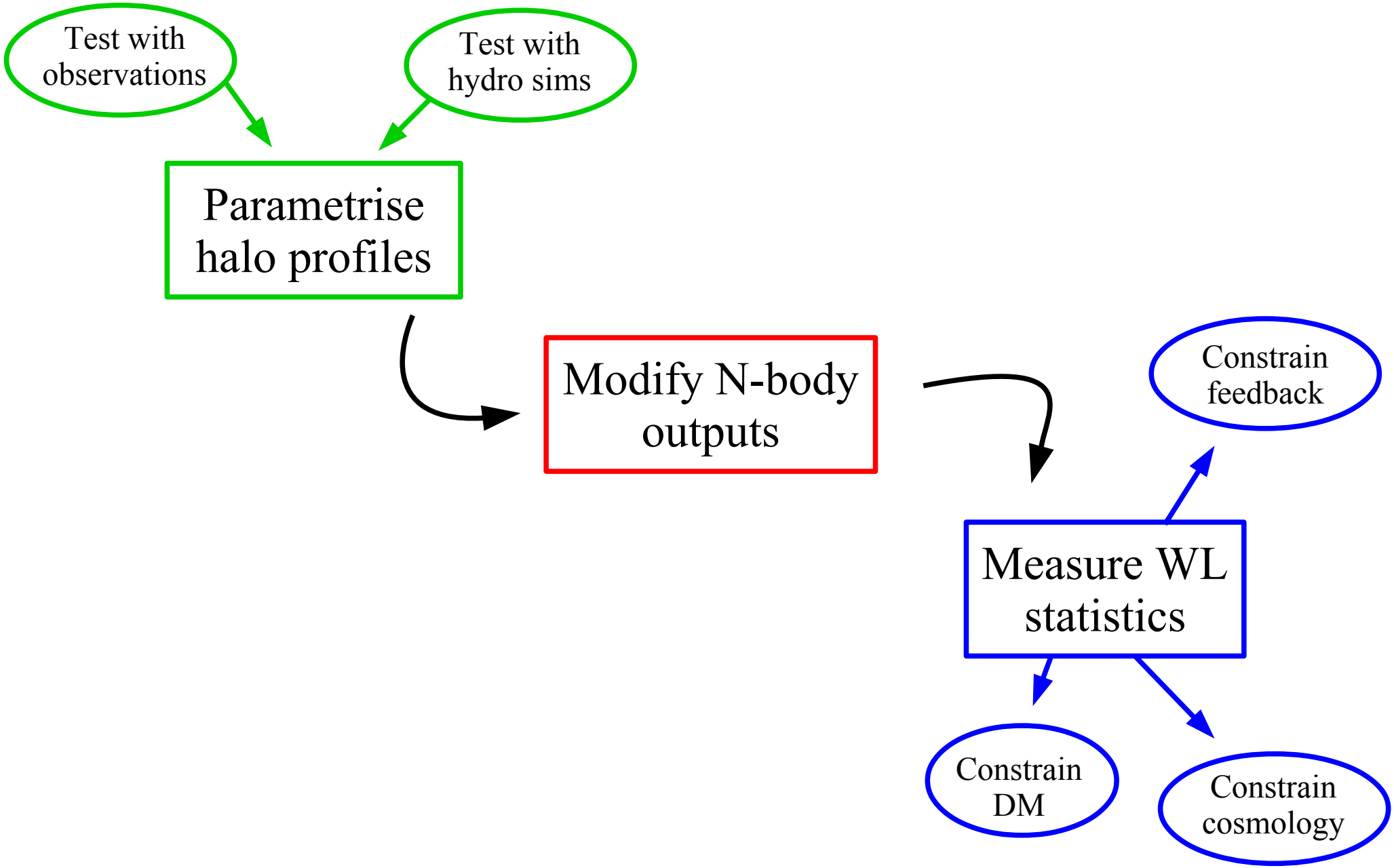

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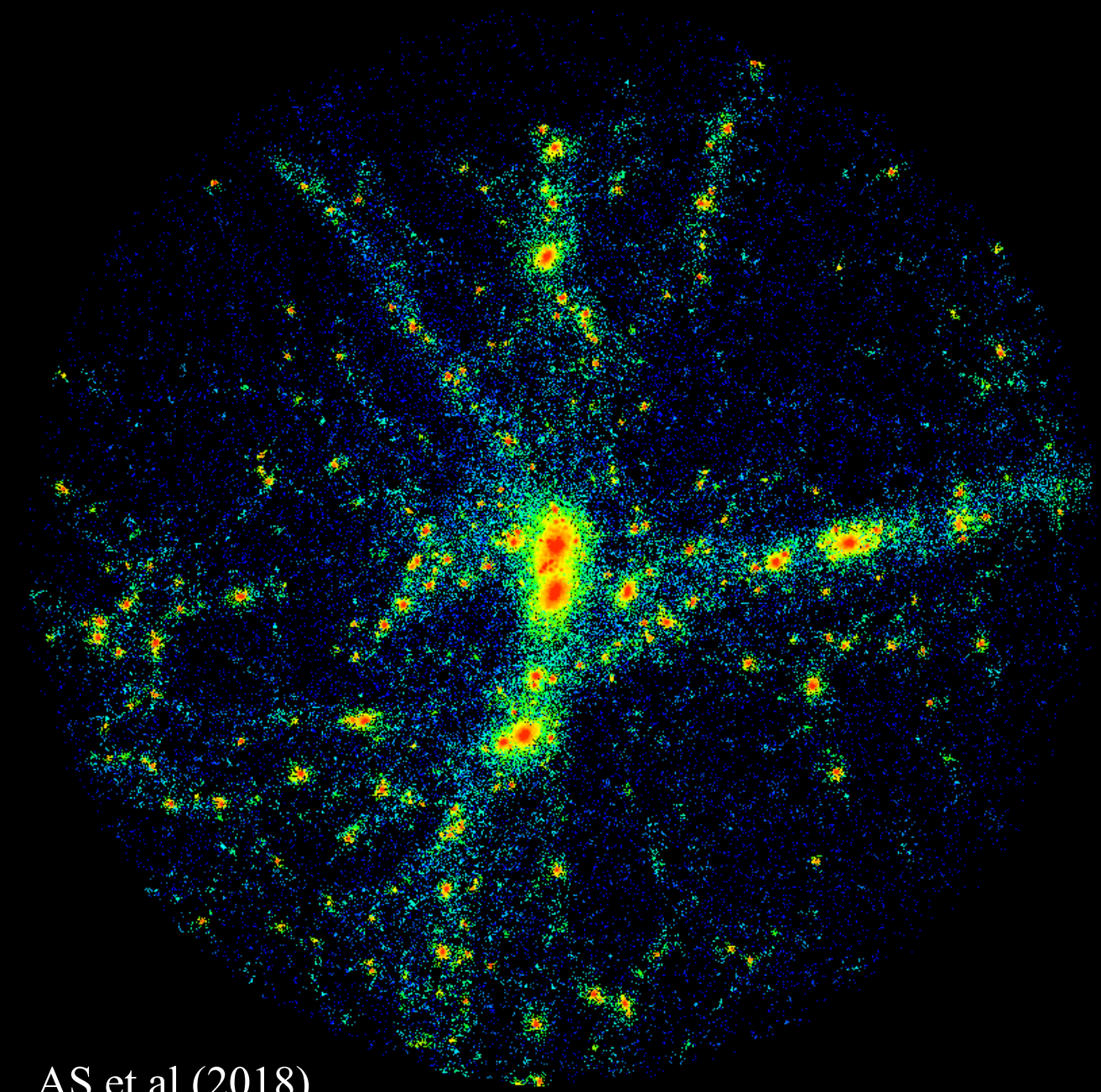
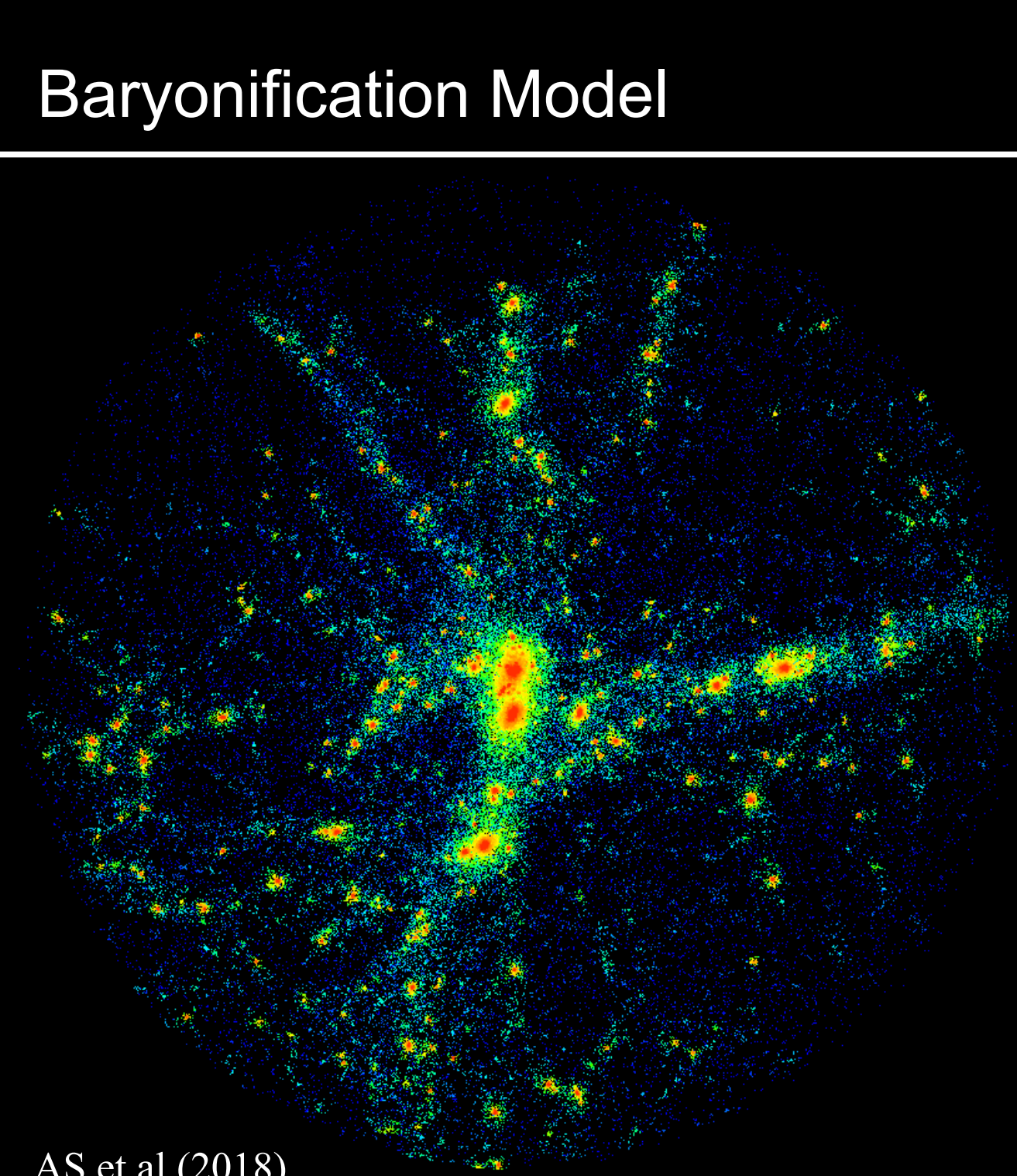


AS et al (2018)

Baryonification Model



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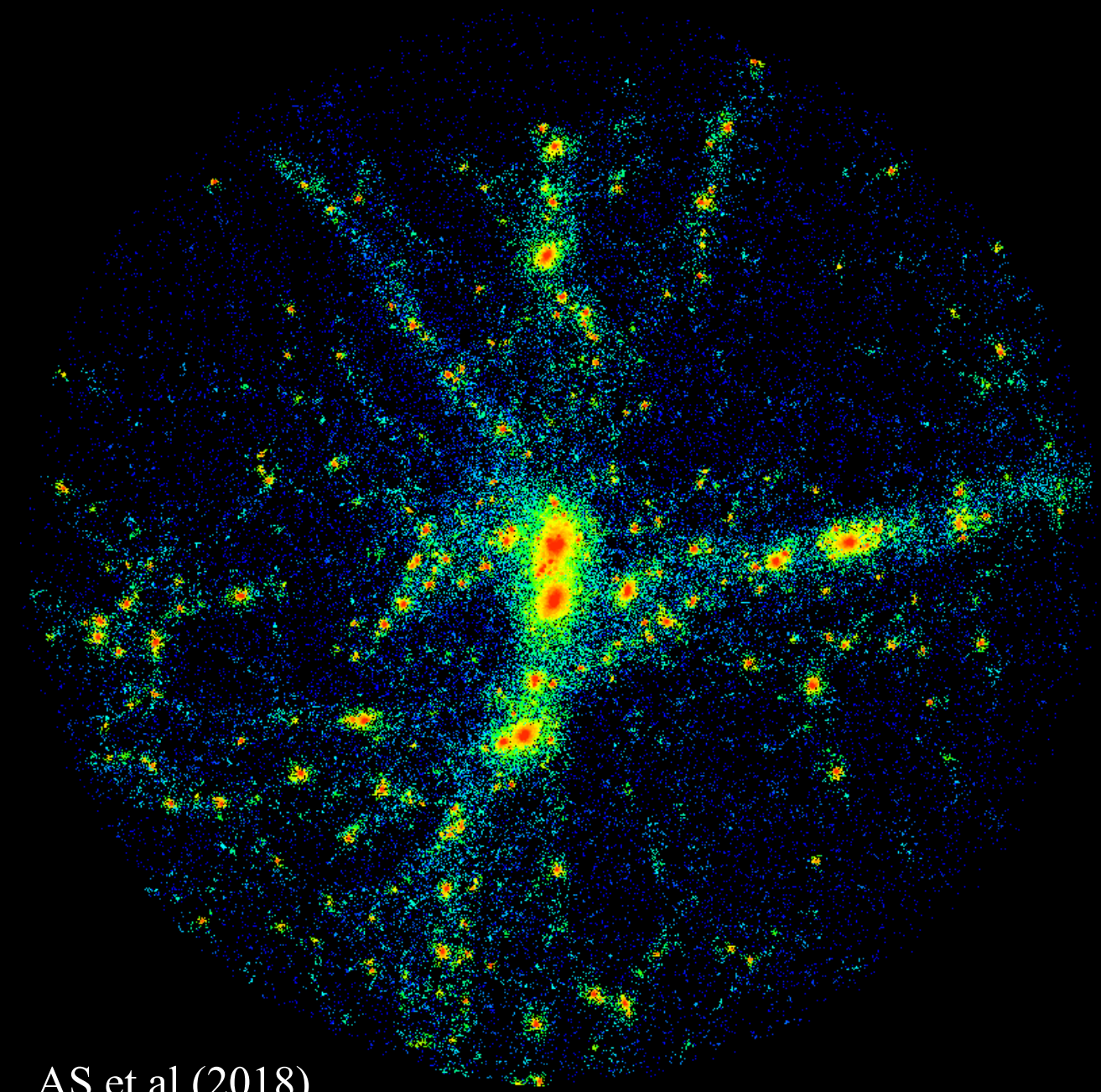
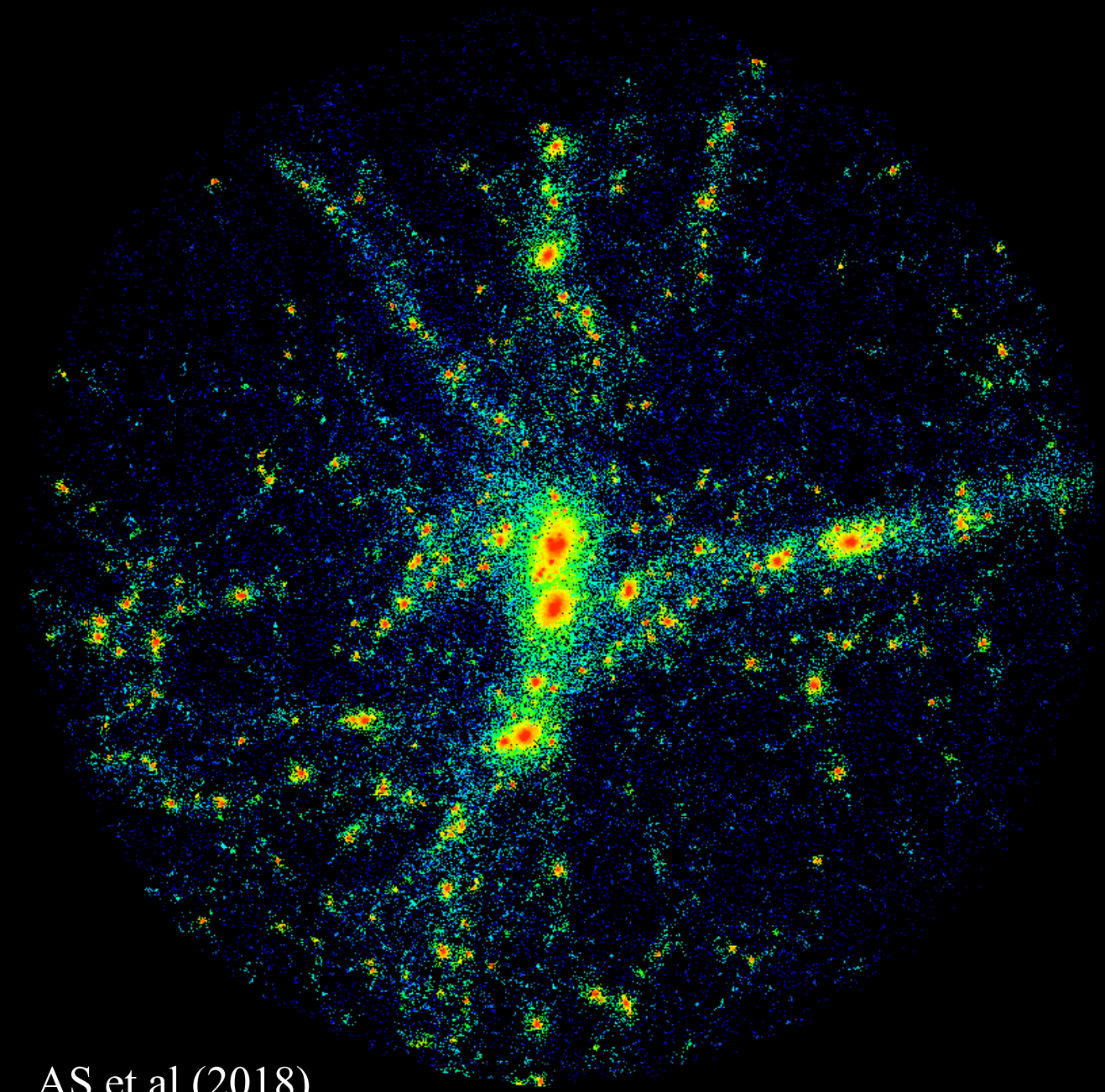


AS et al (2018)

Baryonification Model



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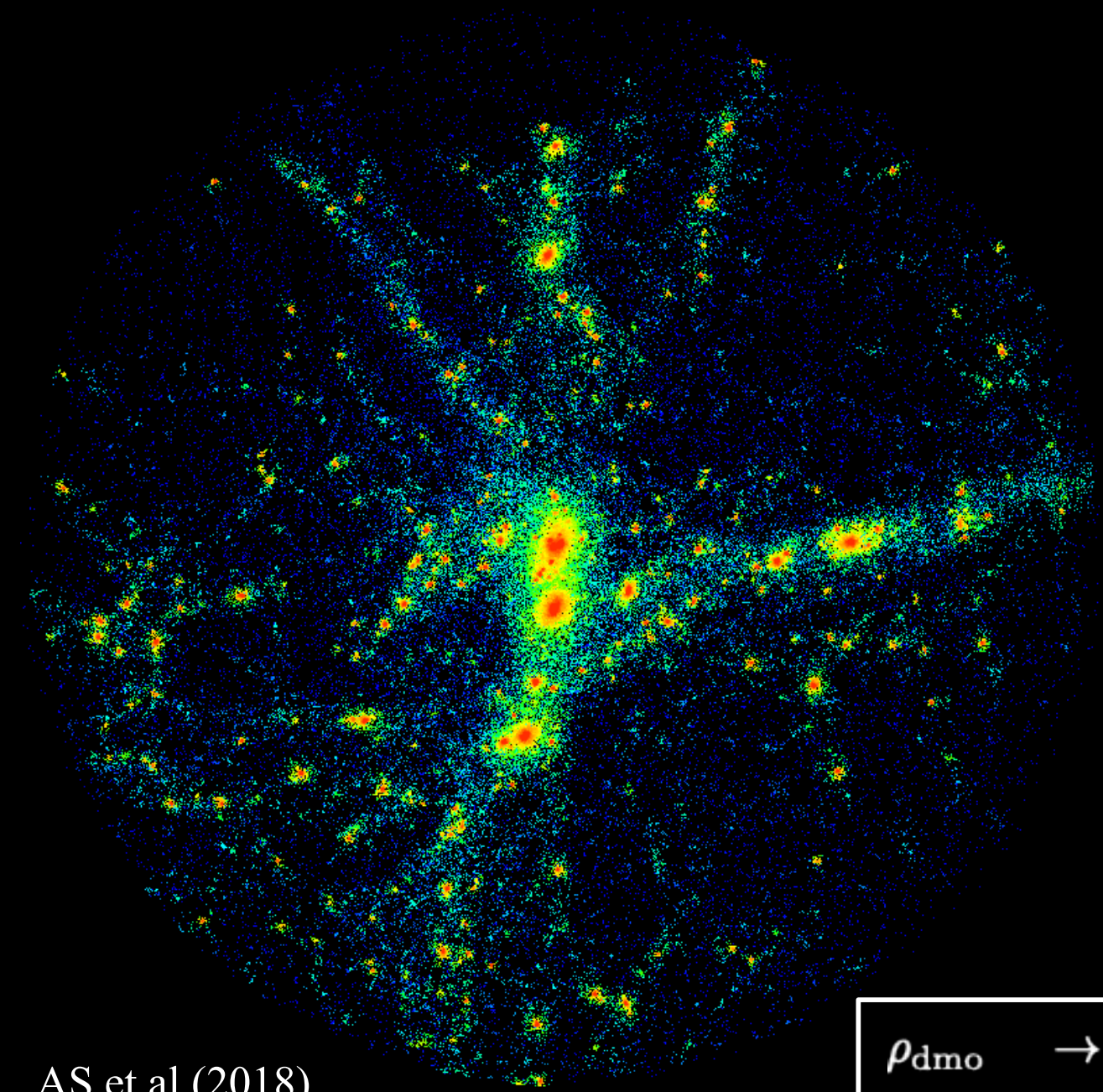
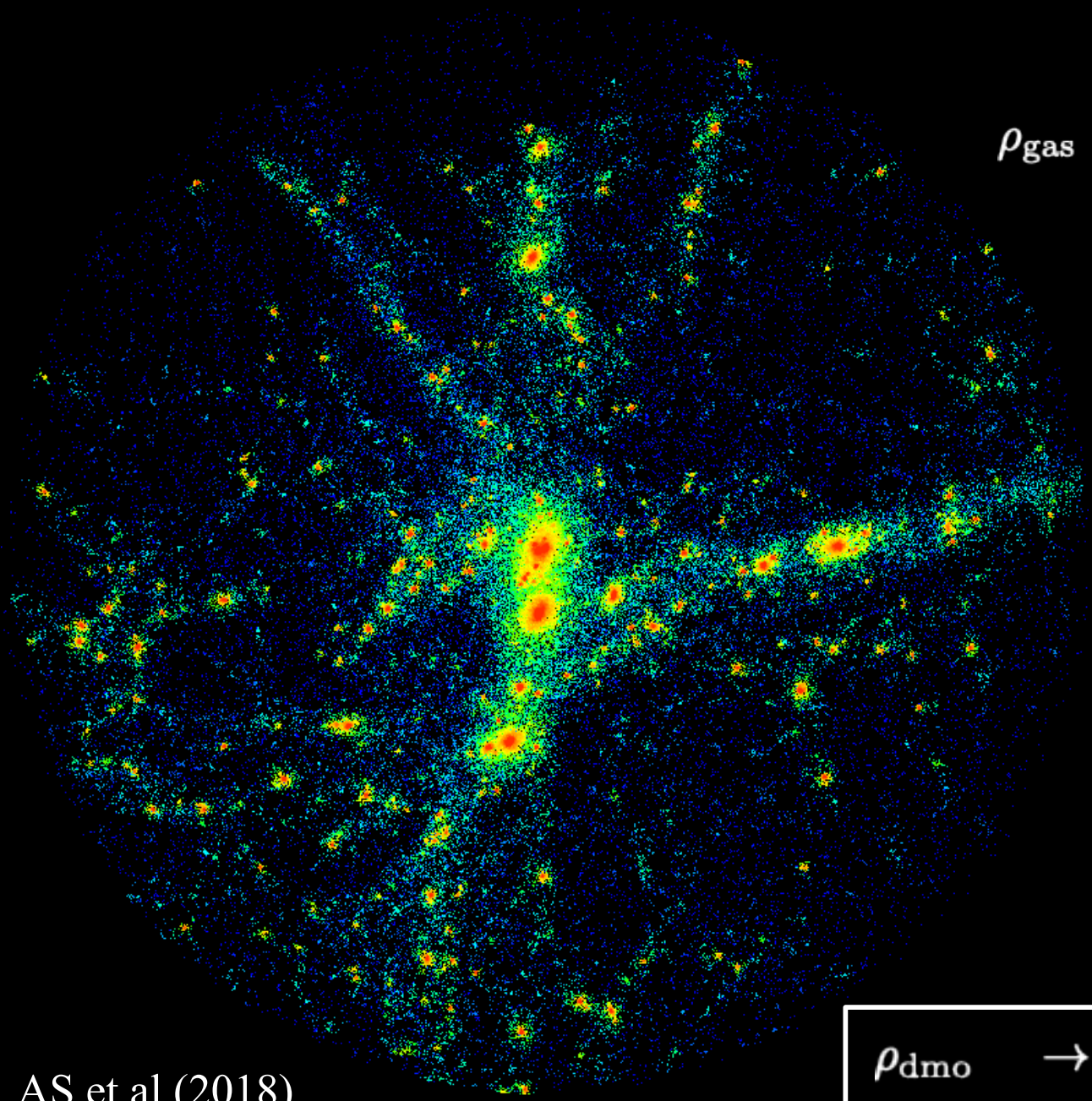


AS et al (2018)

$$\rho_{\rm dmo} \quad \rightarrow \quad \rho_{\rm dmb} = \rho_{\rm dm} + \rho_{\rm gas} + \rho_{\rm stars}$$

Baryonification Model



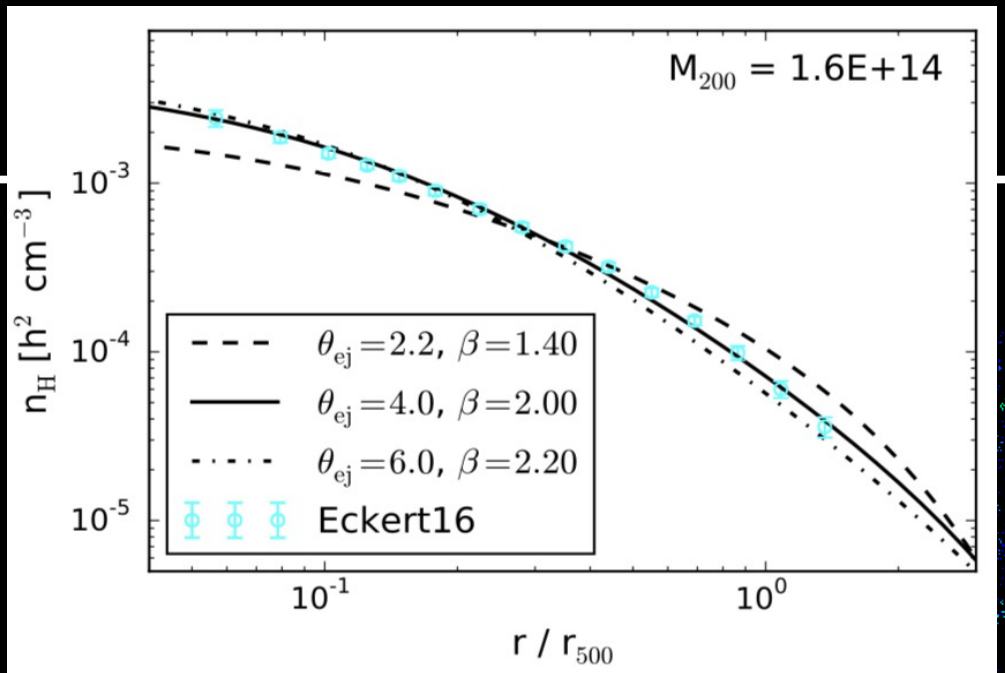
$$\rho_{\rm gas} = \left(1+\frac{r}{r_{\rm co}}\right)^{-\beta}\left(1+\frac{r^2}{r_{\rm ej}^2}\right)^{\frac{7-\beta}{2}}$$

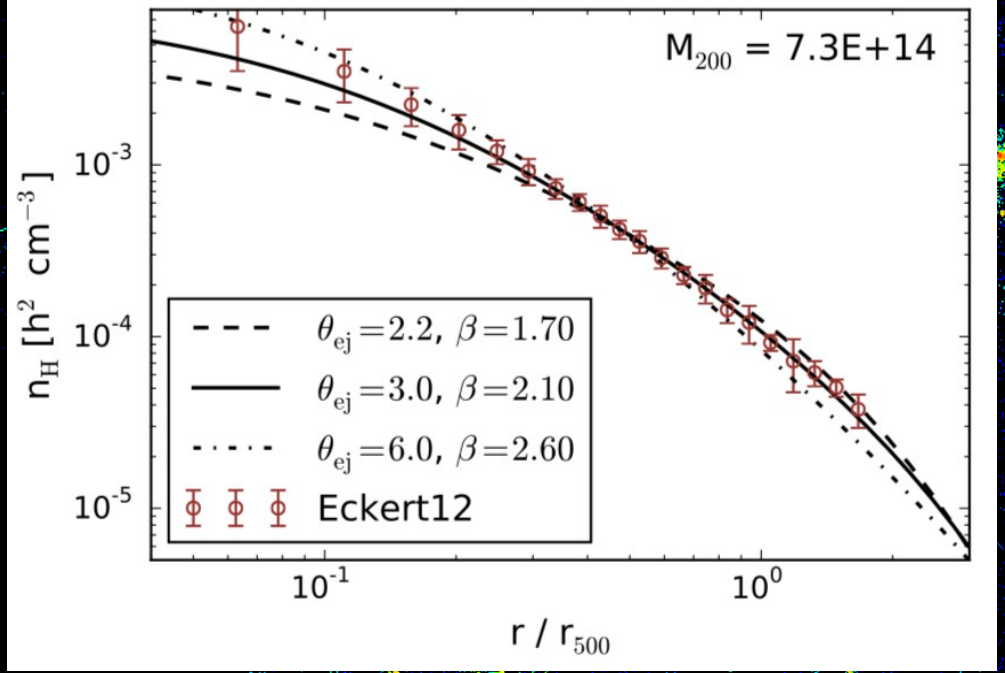
$$\beta = 3-(M_c/M)^{\mu}$$

$$r_{\rm ej} = \theta_{\rm ej} r_{\rm vir}$$

$$\rho_{\rm dmo} \quad \rightarrow \quad \rho_{\rm dmb} = \rho_{\rm dm} + \rho_{\rm gas} + \rho_{\rm stars}$$

AS et al (2018)





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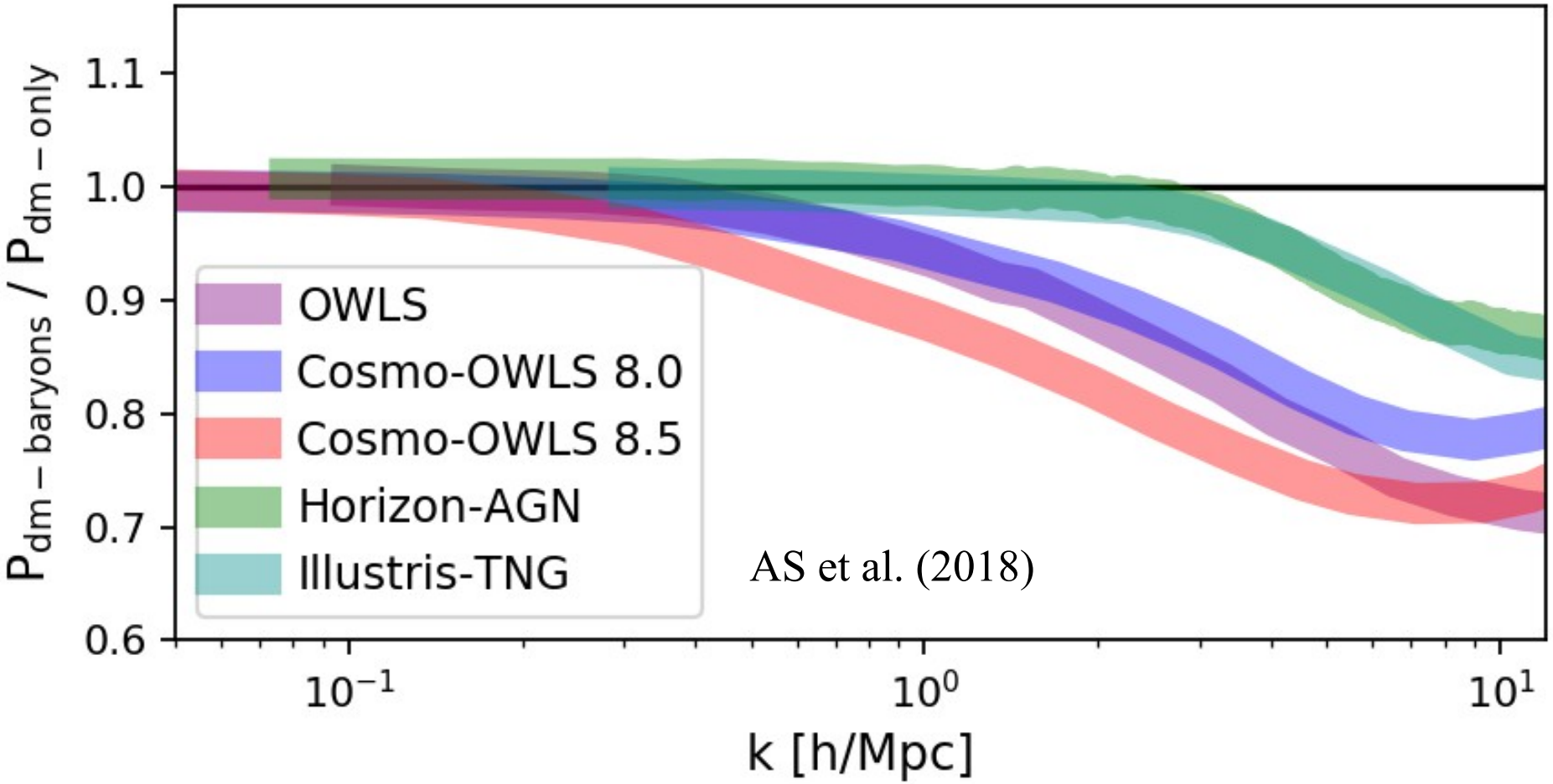
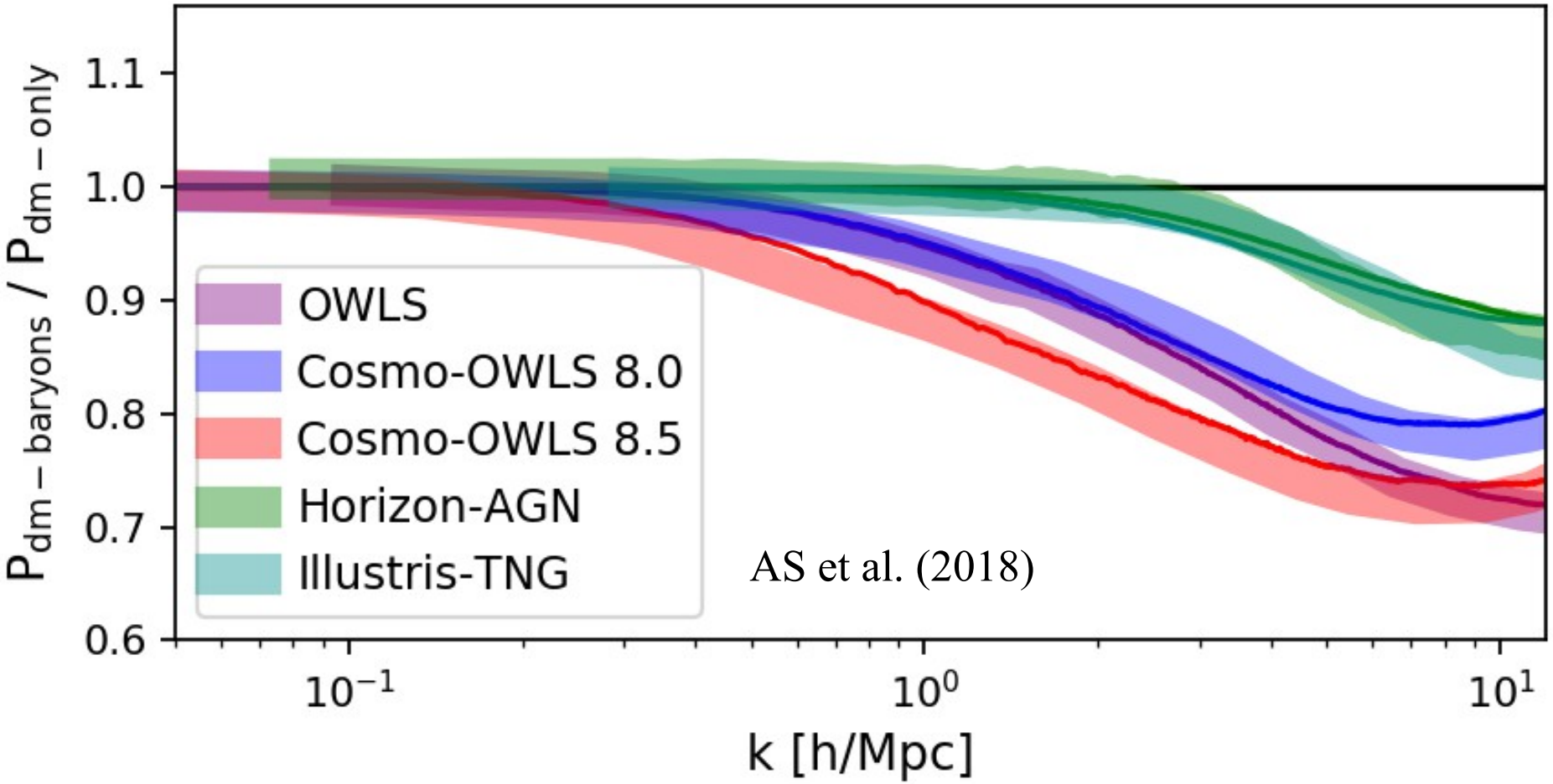


Baryonification Model



Not a fit to the power spectrum!

What to do from here ...

WL convergence peaks

(Weiss et al. 2019)

Cosmic shear correlation

(AS et al. 2018)

Galaxy clustering analysis

(Knabenhans et al. in prep)

Forecast for WL surveys

(AS et al. 2019a,b)

Galaxy-galaxy lensing

(Ardila et al. in prep)

WL map analysis with Neural Nets

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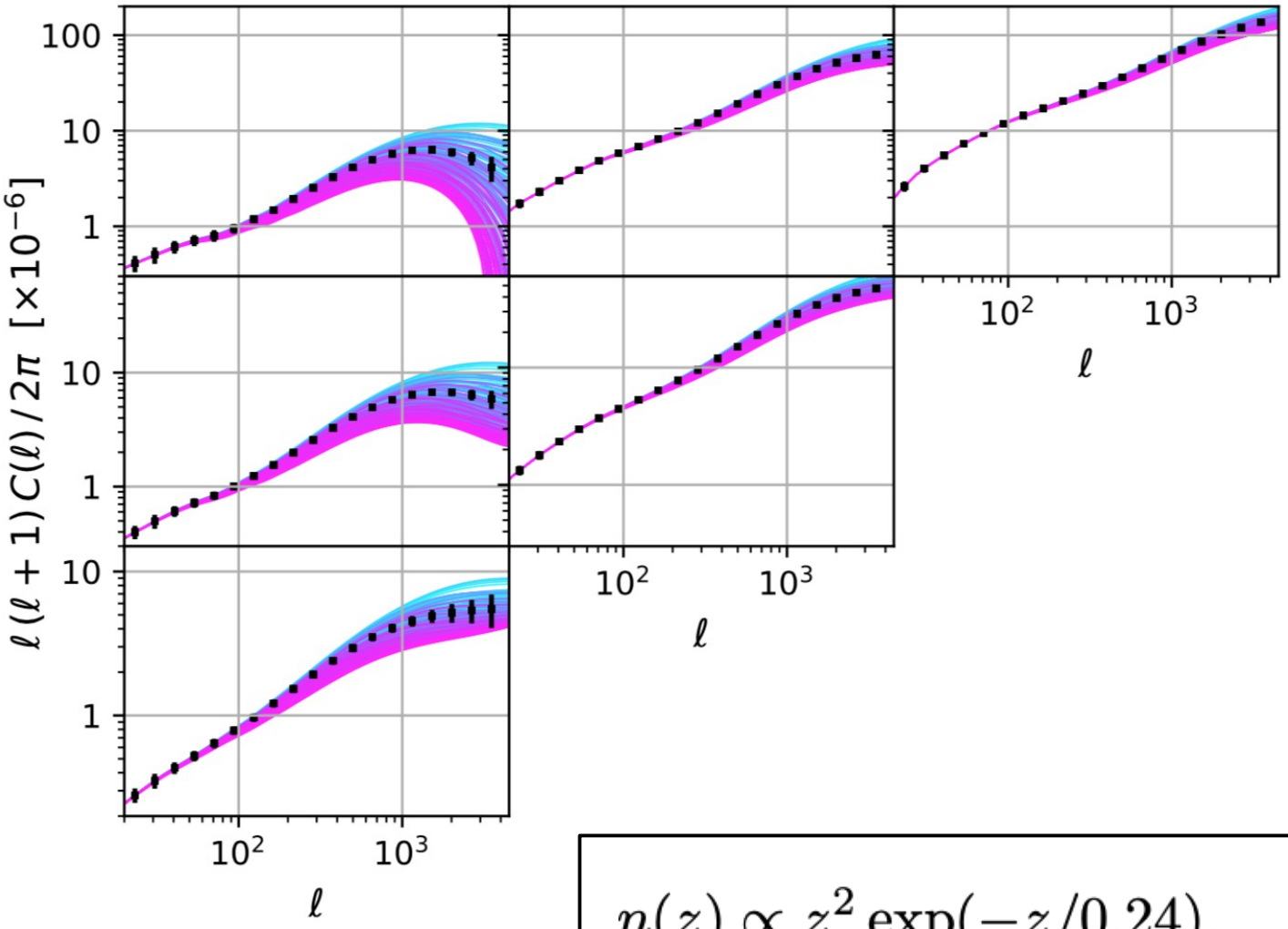
Mock data

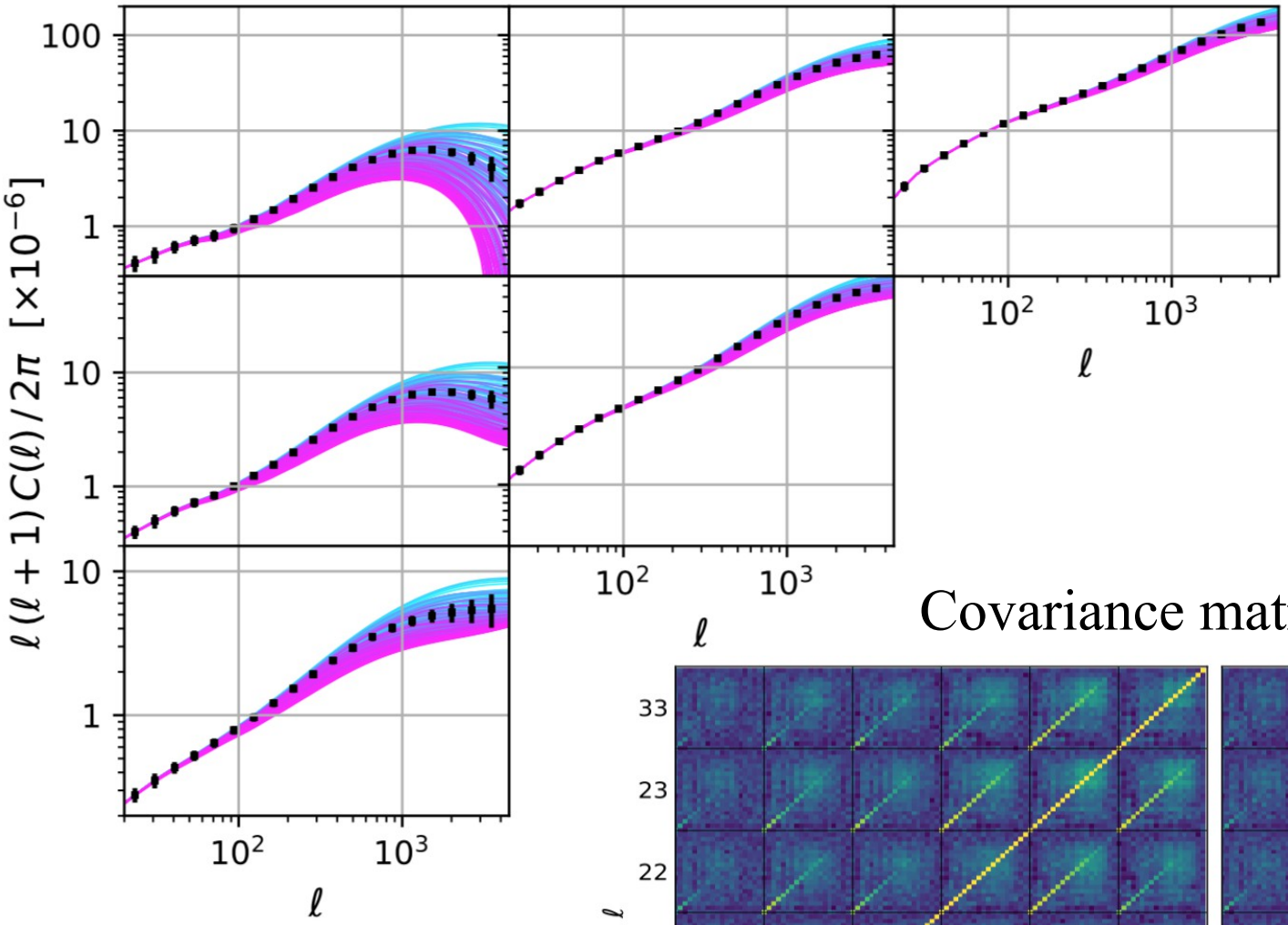
Mock data – Weak Lensing (stage IV)



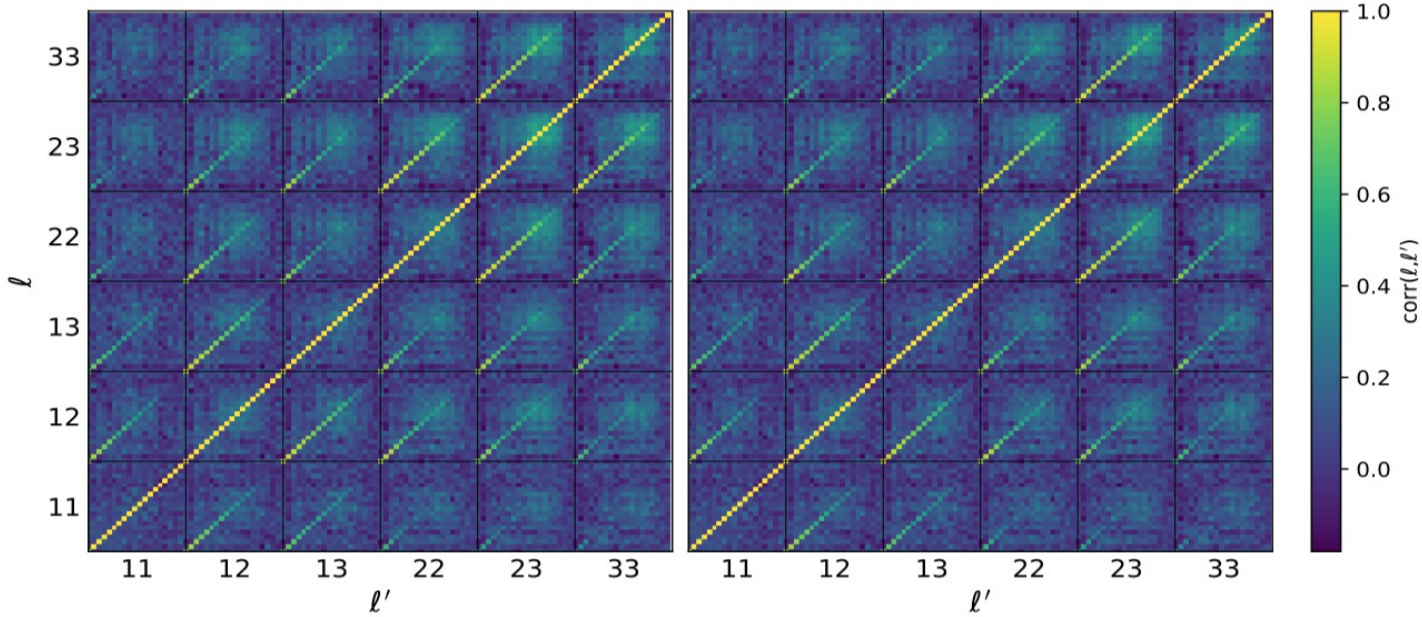
$$n(z) \propto z^2 \exp(-z/0.24), \qquad z \in [0.1, 1.5]$$

$$\text{Area} = 20000\,\text{deg}^2, \qquad n_{\text{gal}} = 30\,\text{arcmin}^{-2}$$

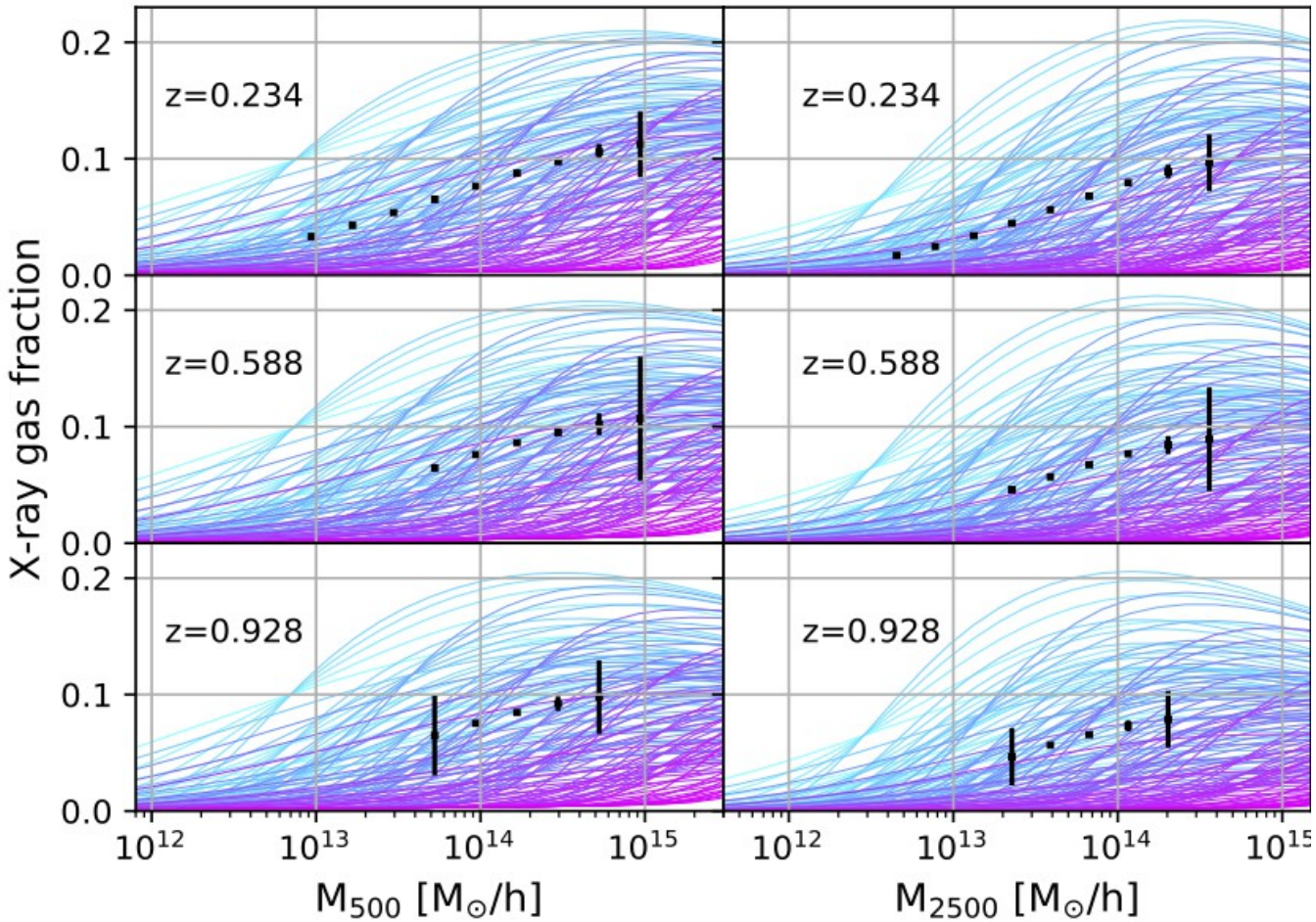
Mock data – Weak Lensing (stage IV)



Covariance matrix from simulations



Mock data – X-ray gas fractions (eROSITA)



→ Gas mass from eROSITA, total halo mass from Euclid

see Grandis et al. (2018)

Forecast

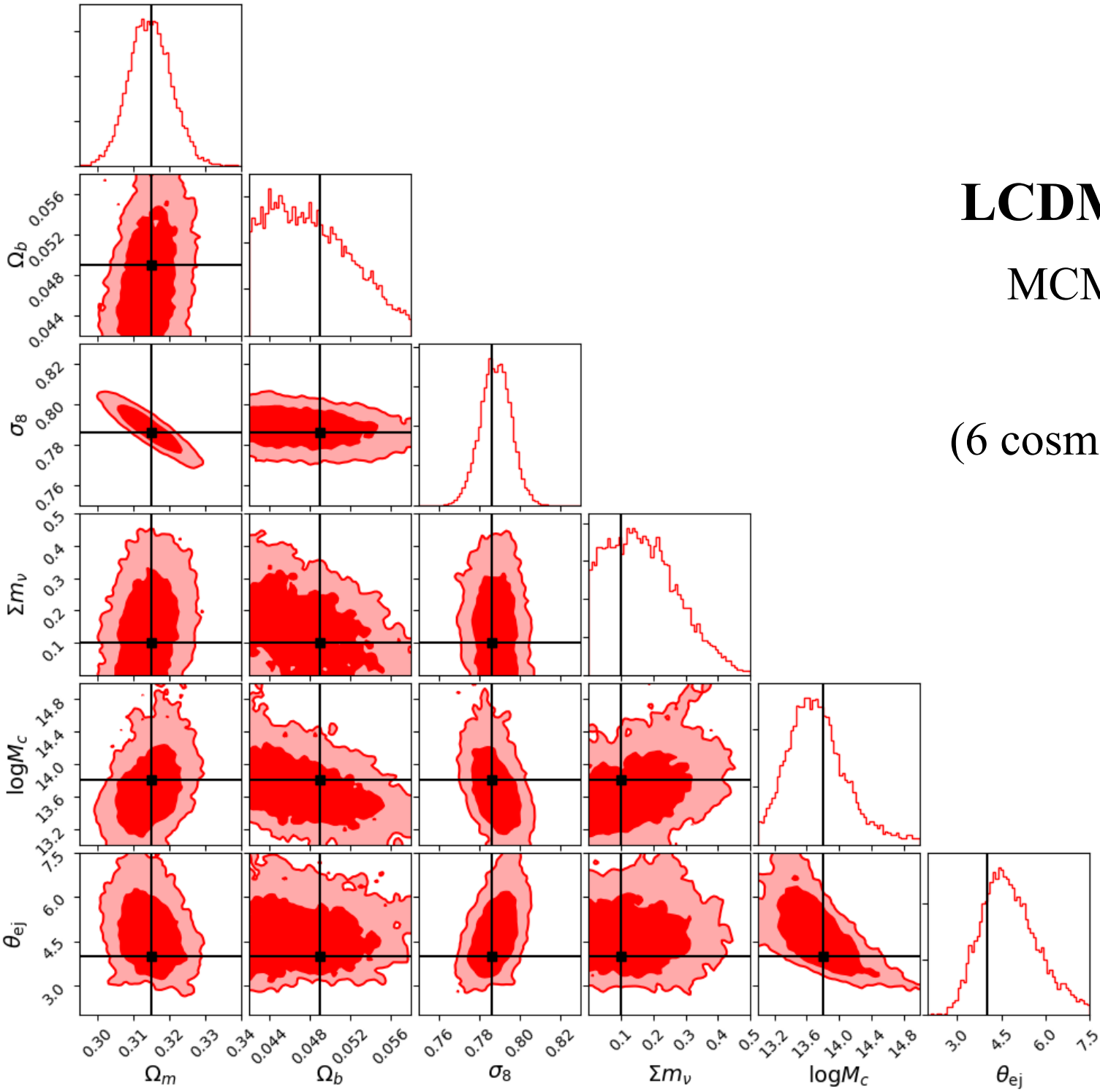
LCDM with neutrinos

MCMC param. inference

10 parameters

(6 cosmo / 3 baryons / 1 IA)

Cosmic shear only



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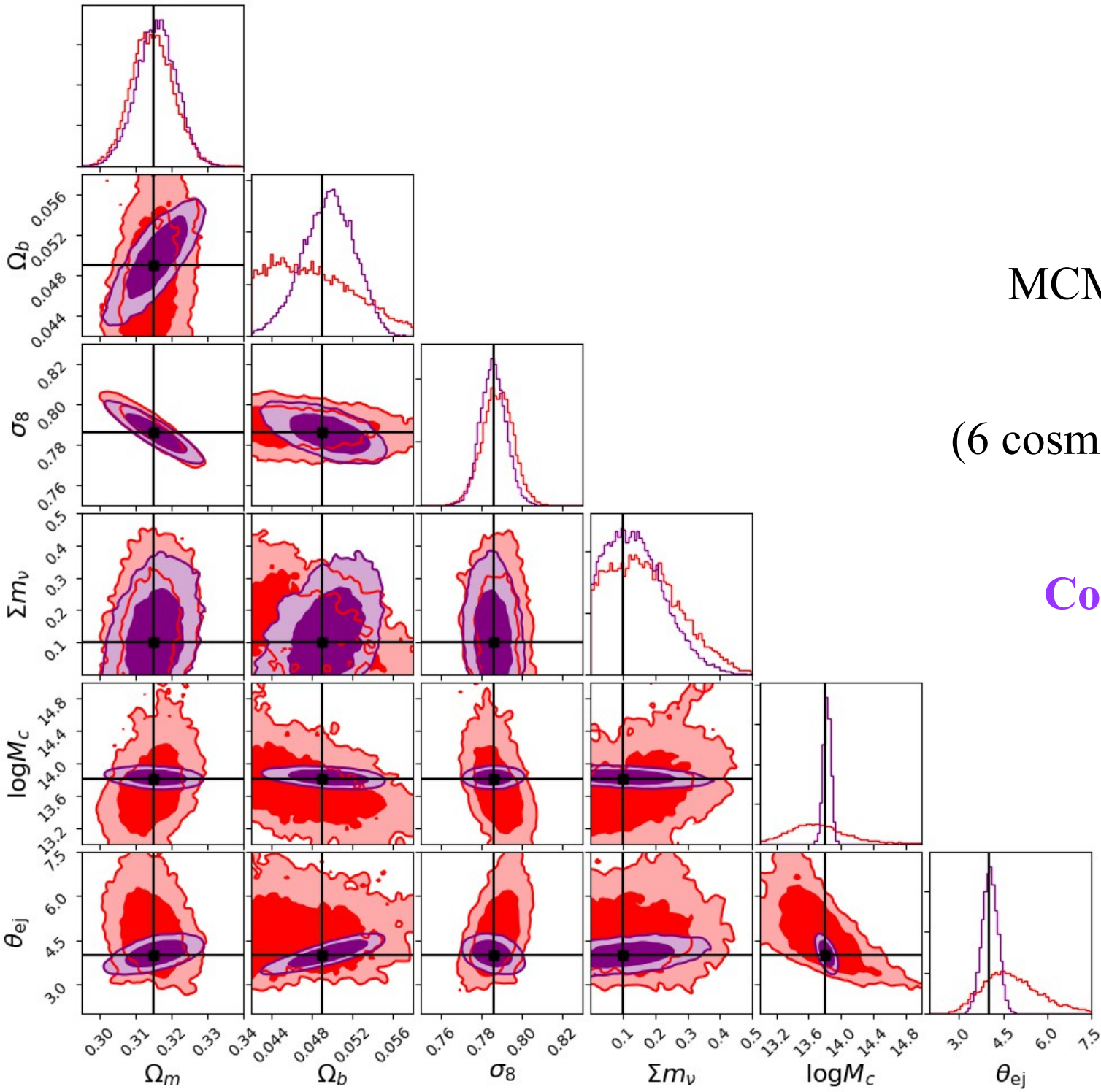

LCDM

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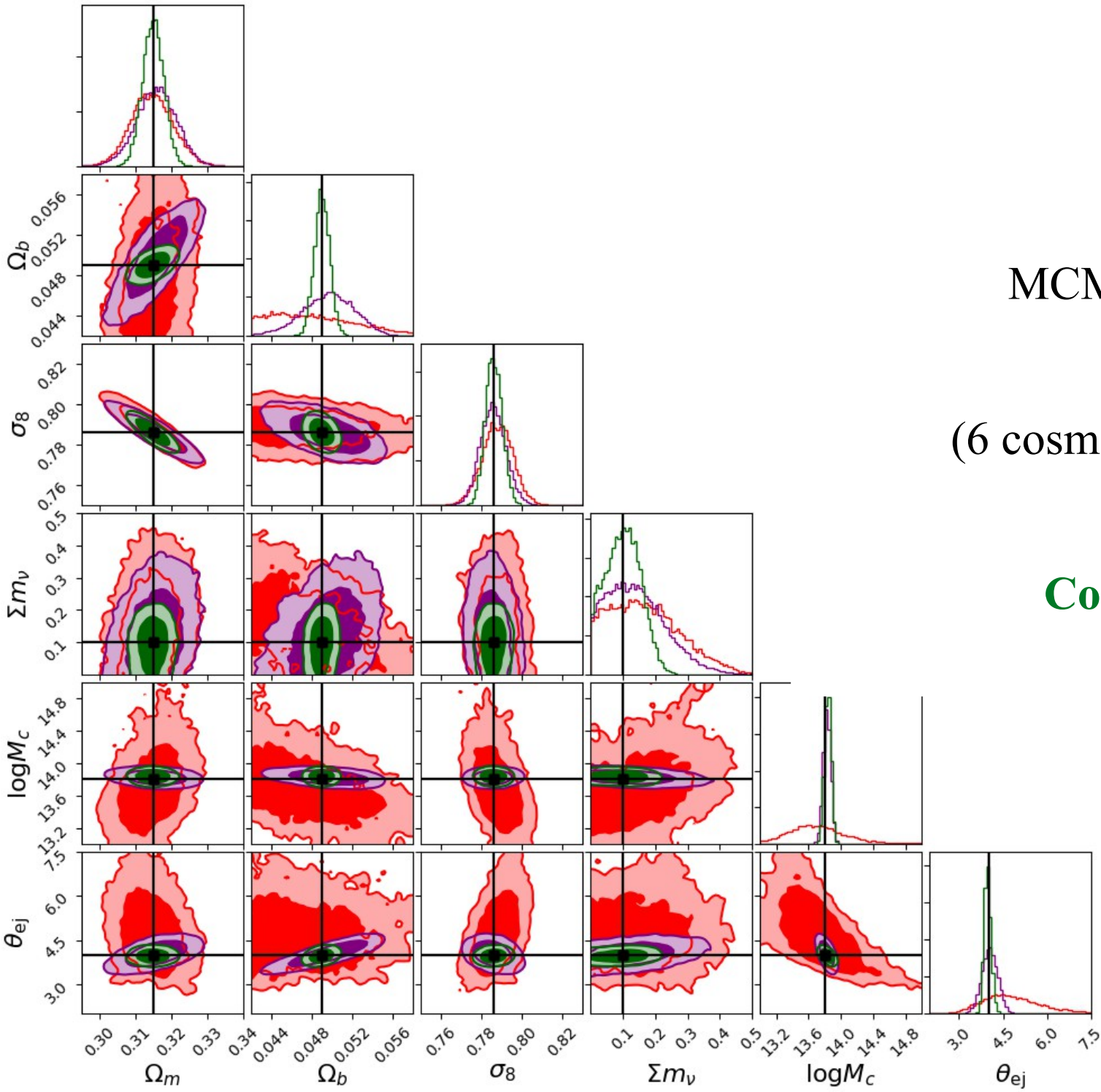
Cosmic shear + X-ray



LCDM

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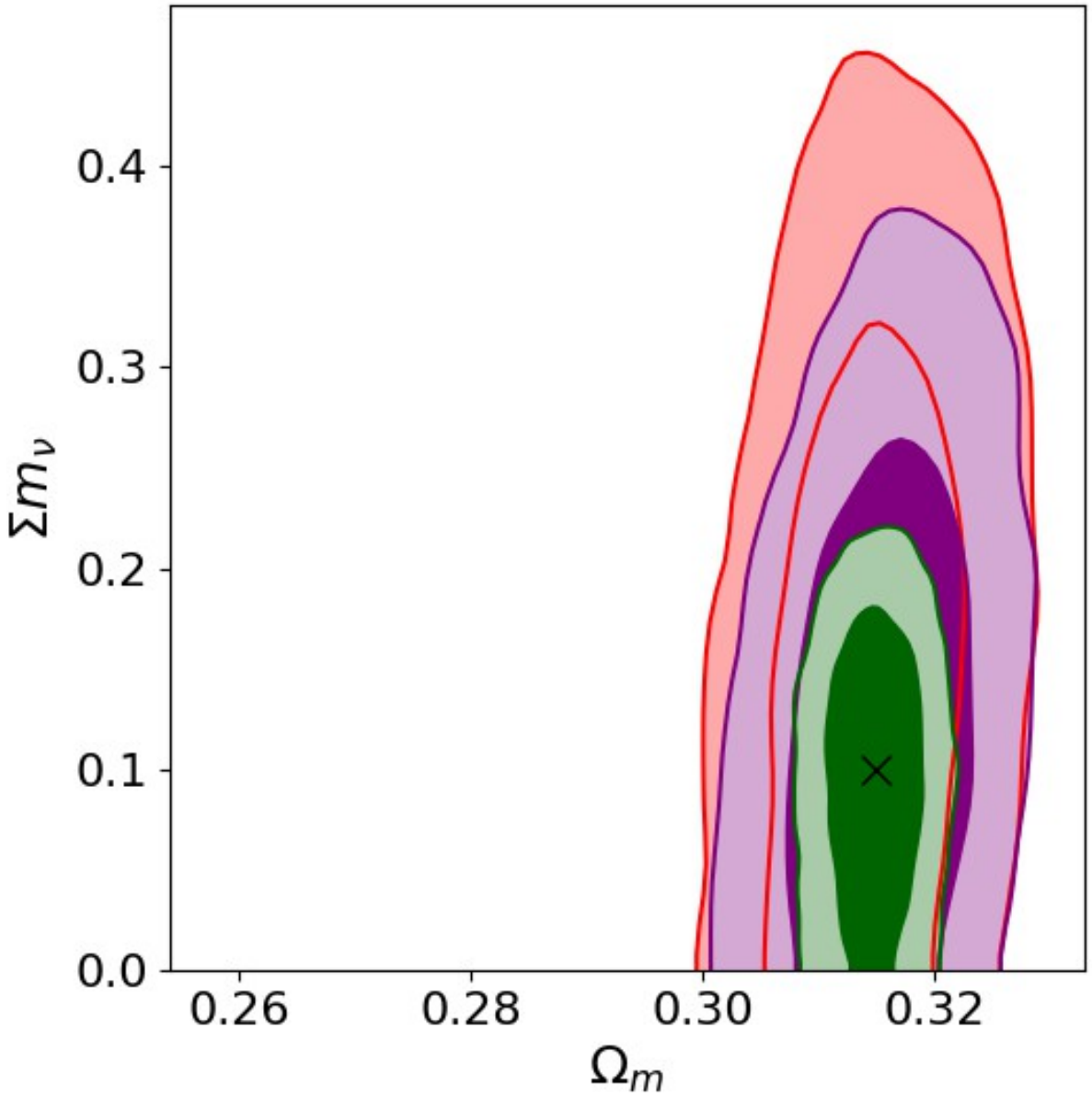
Cosmic shear + X-ray

+ CMB-p5

Weak lensing forecast – Neutrinos



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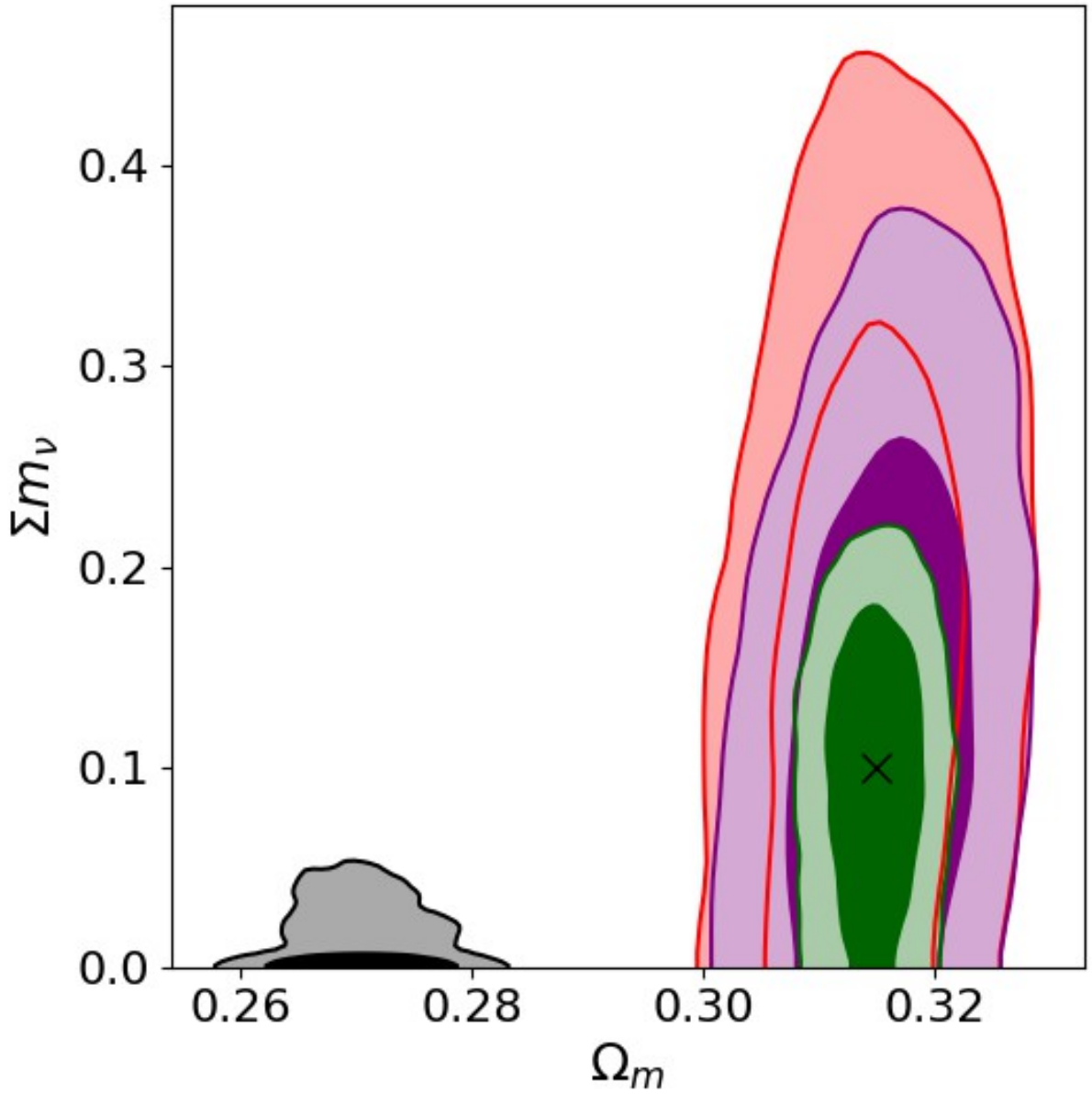

LCDM

MCMC param. inference

10 parameters

(6 cosmo / 3 baryons / 1 IA)

Cosmic shear only

(no baryons)

Weak Lensing Forecast – Dark Energy

wCDM cosmology

MCMC param. inference

- 6 cosmological,
- 3 baryonic,
- 1 IA,
- 2 DE parameters

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wCDM cosmology

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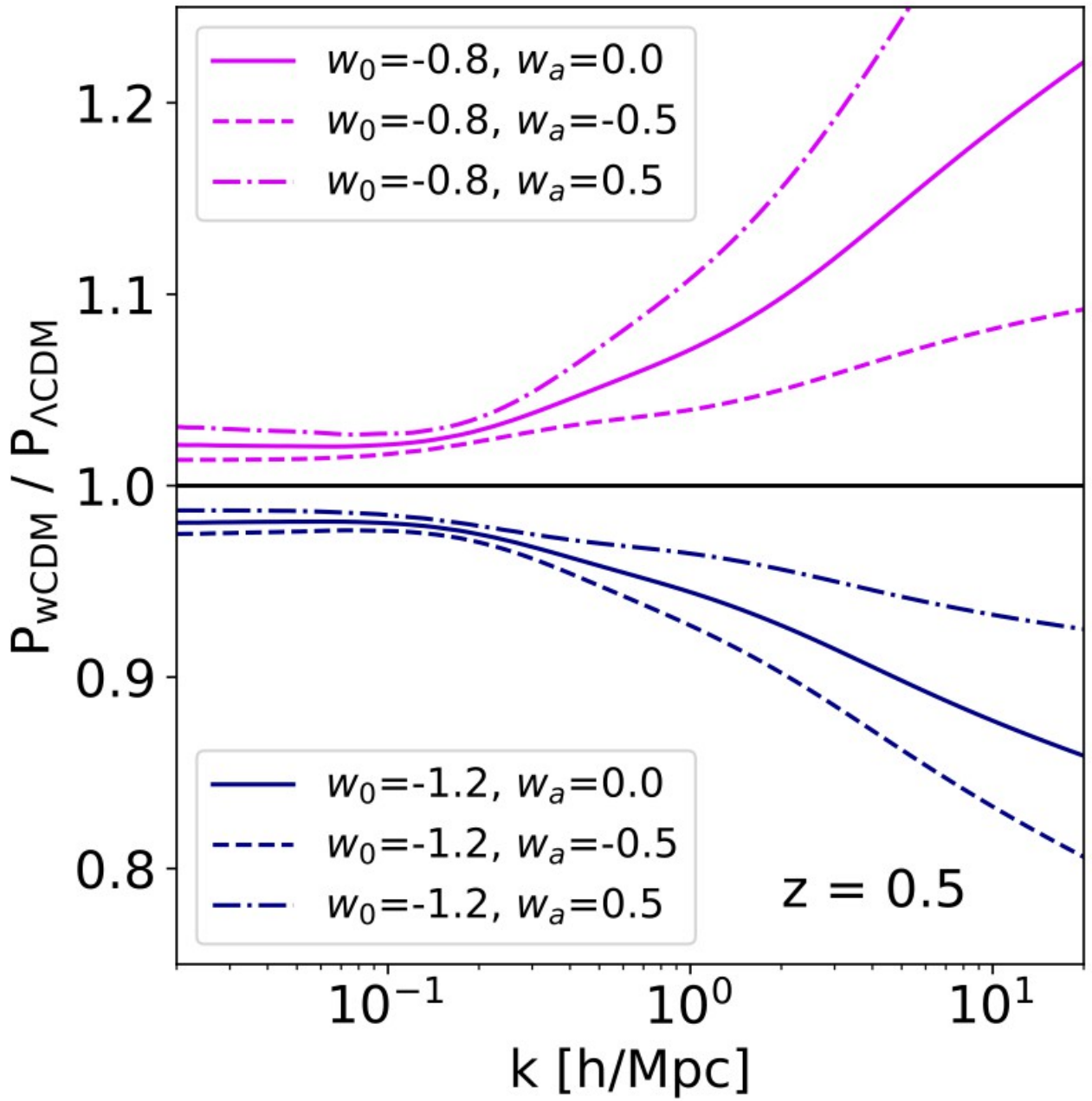

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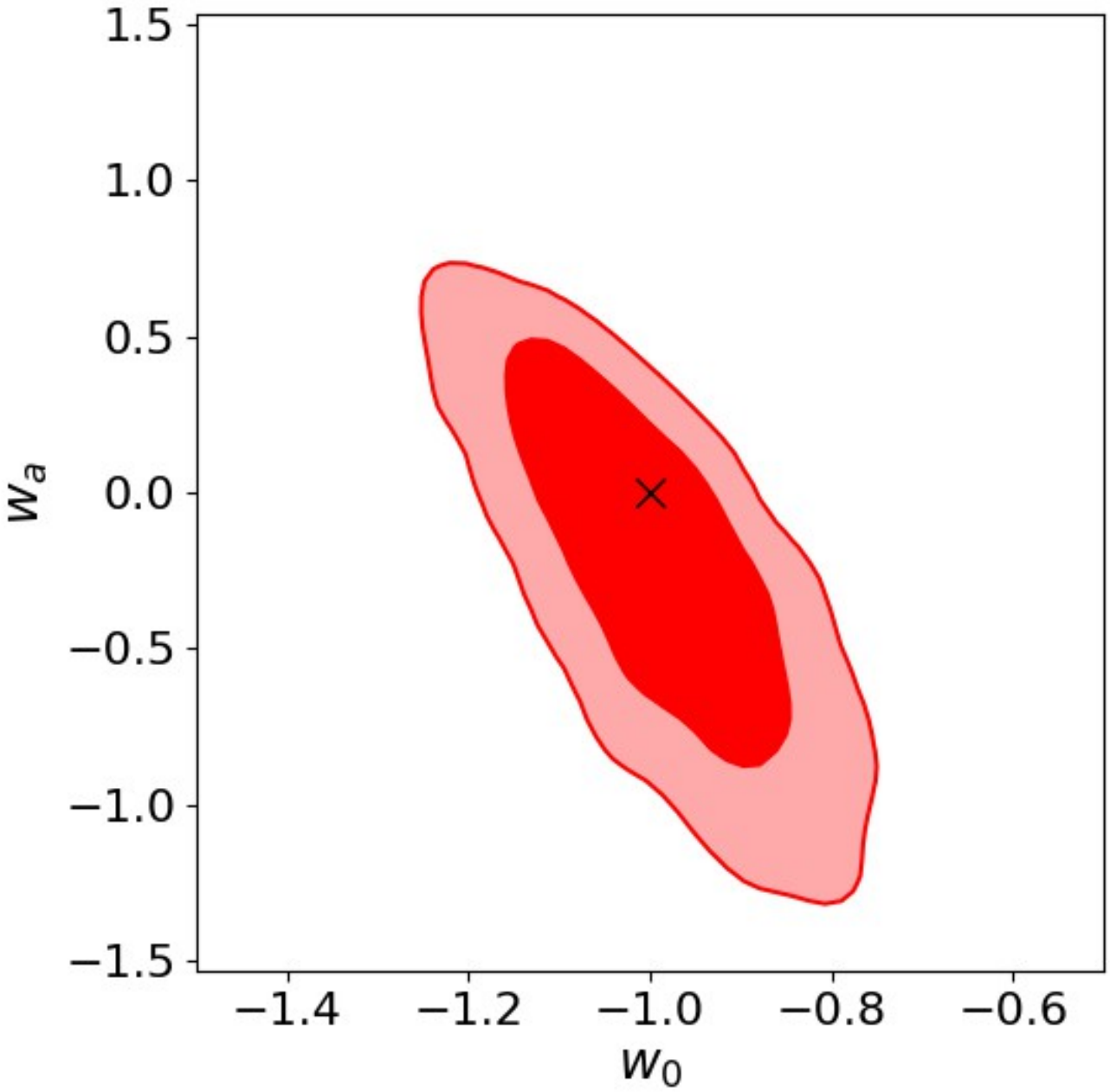
1 IA,

2 DE parameters

Cosmic shear only



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MCMC param. inference

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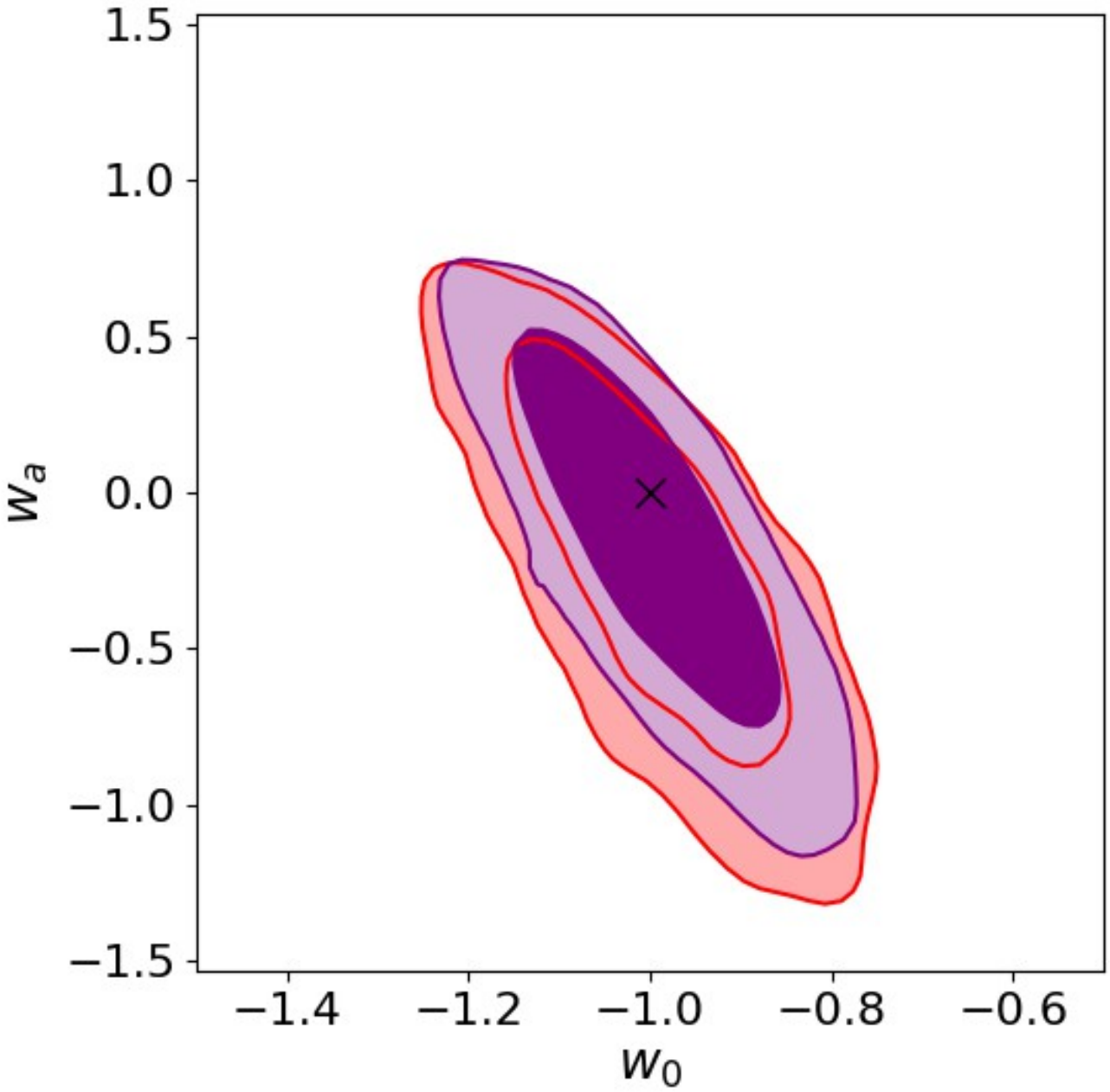
Cosmic shear + X-ray



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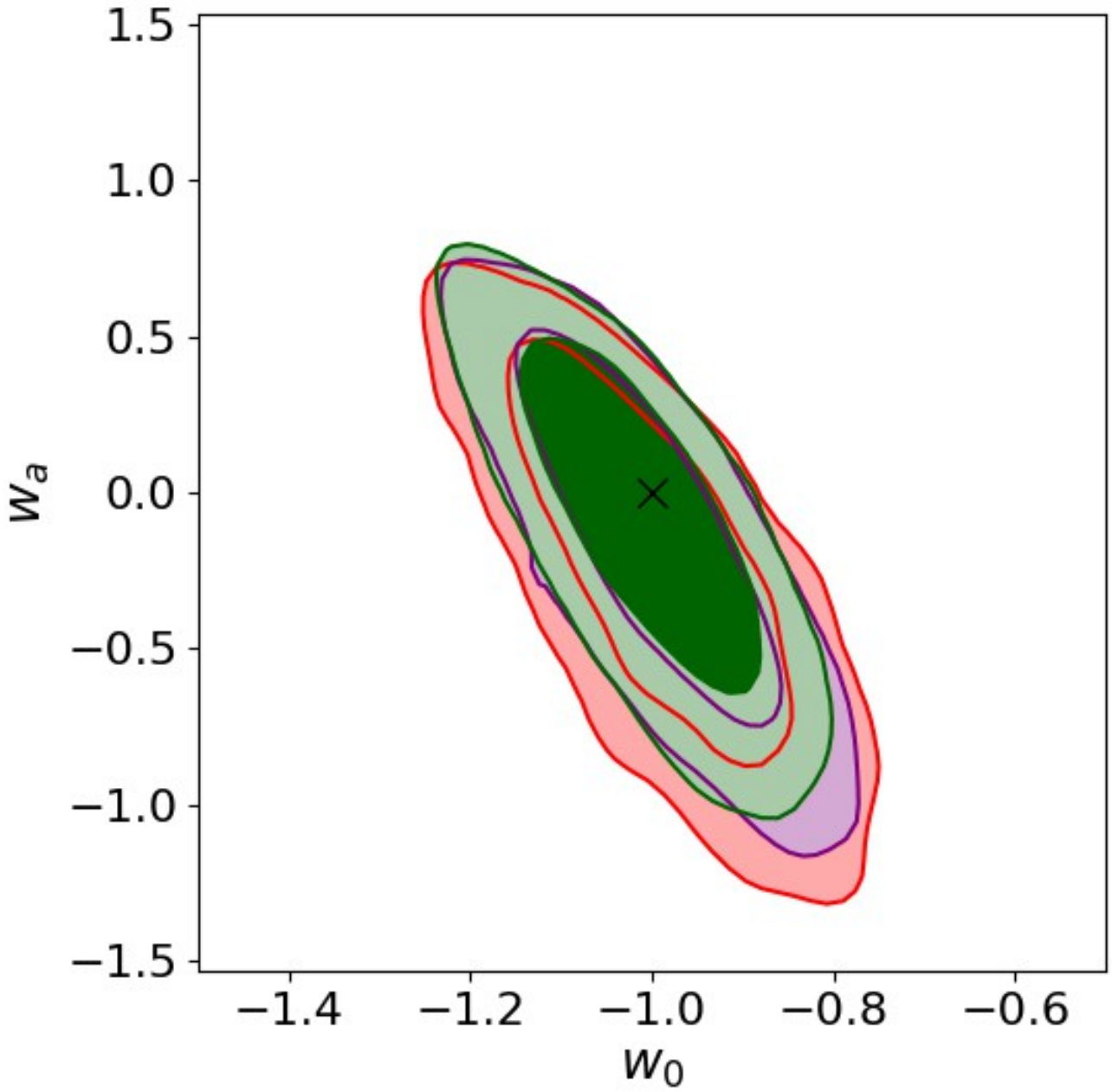

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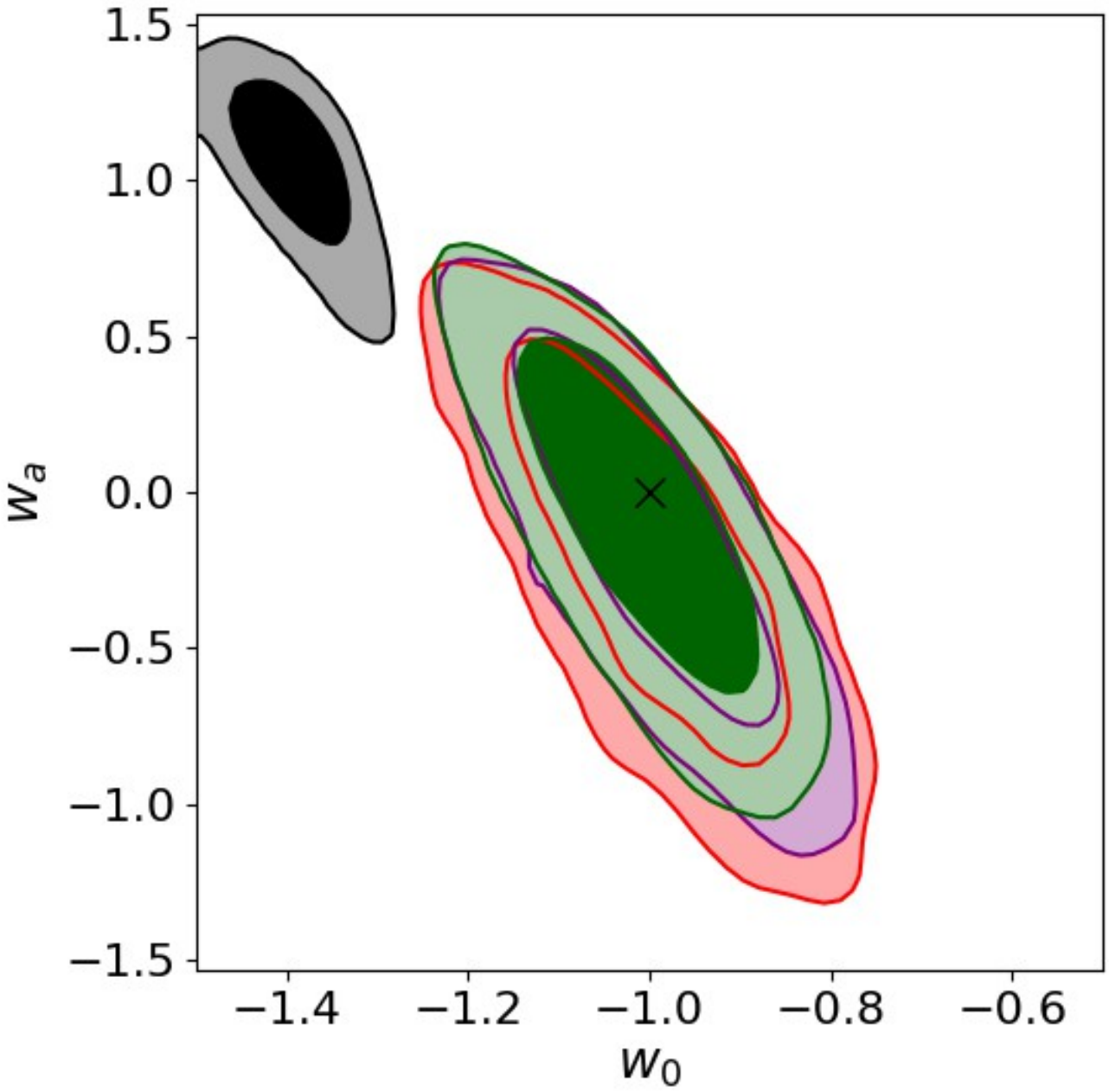

Weak Lensing Forecast – Modified Gravity

f(R) modified gravity

MCMC param. inference

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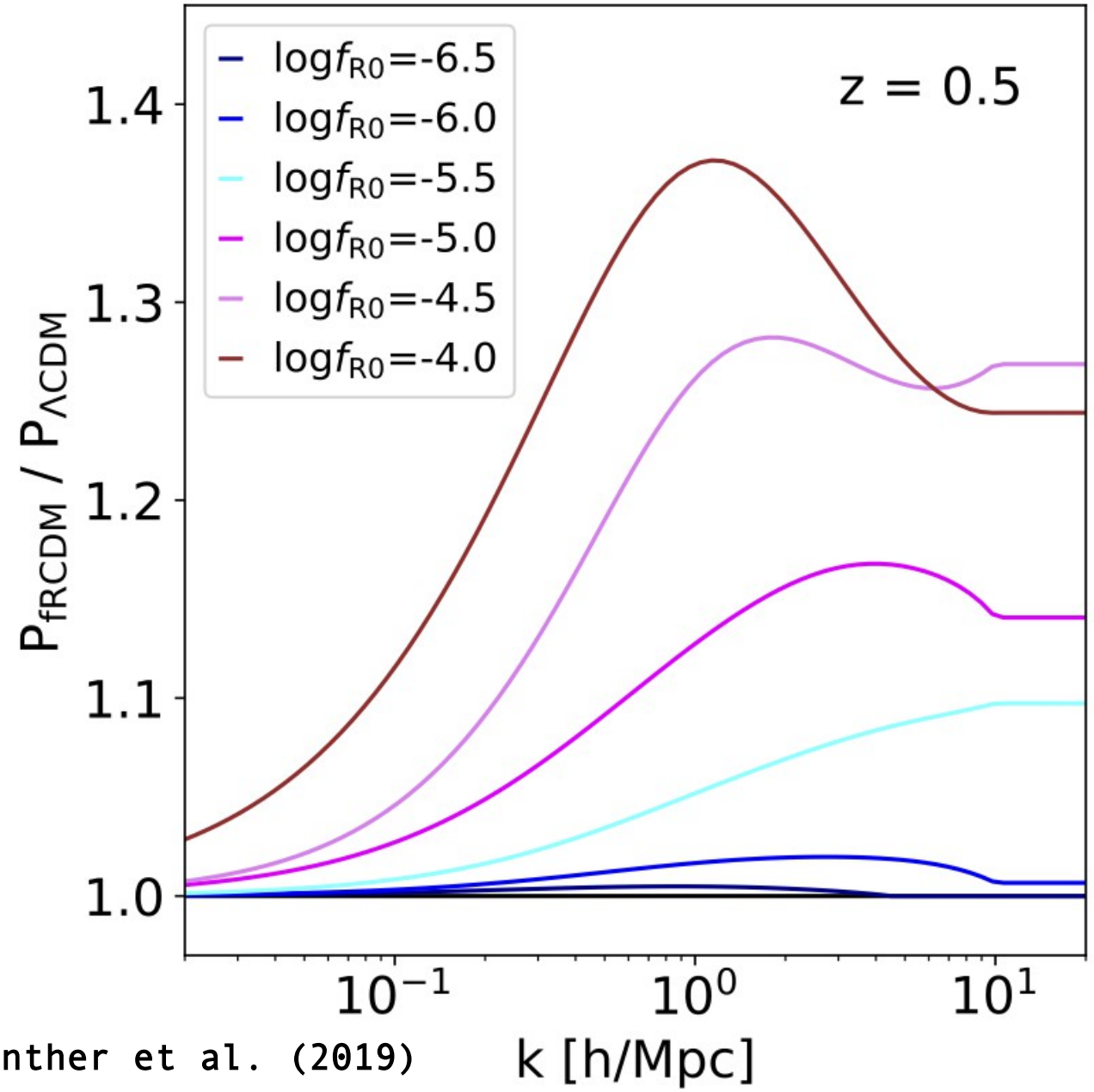

Winther et al. (2019)

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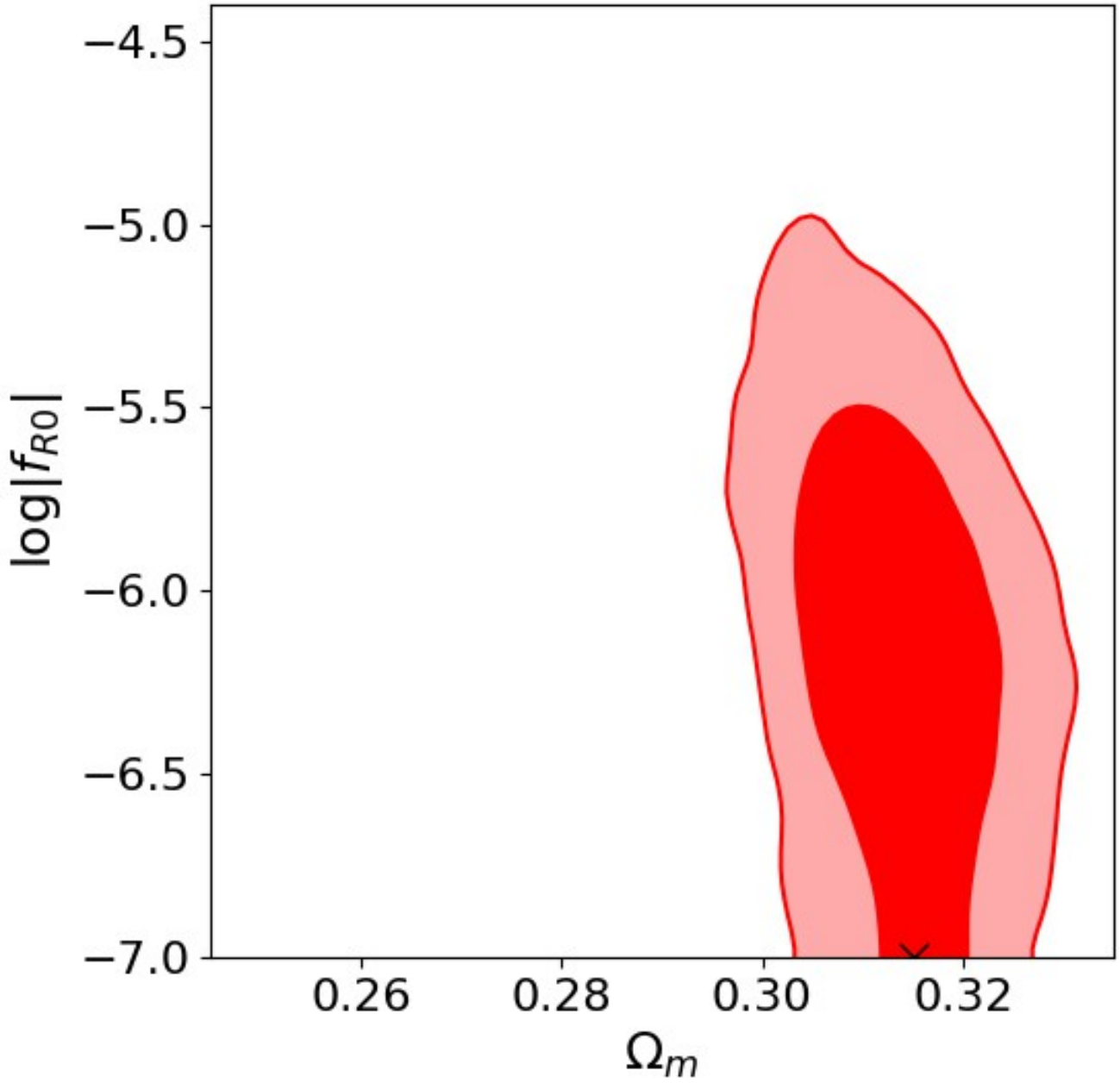

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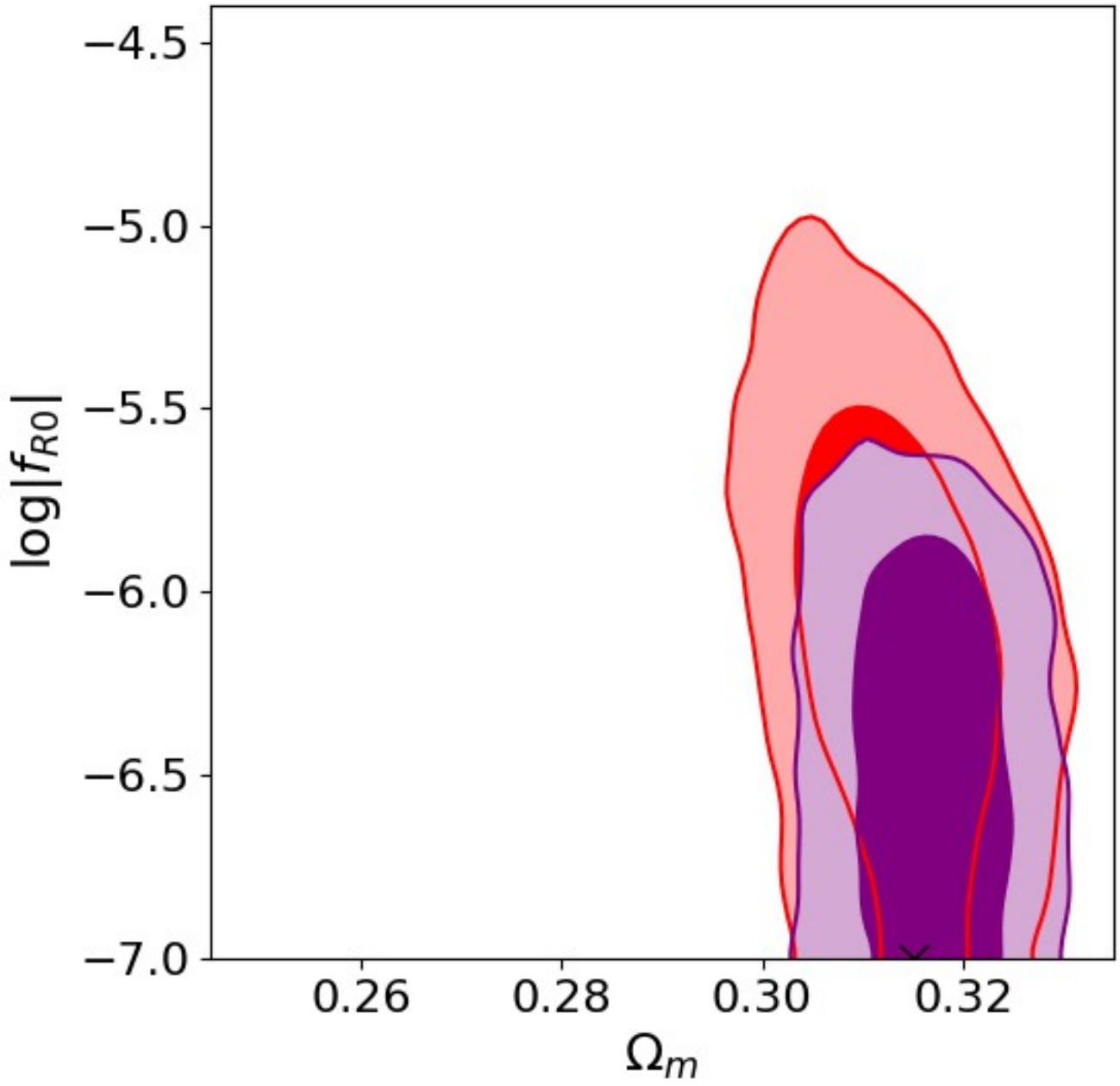

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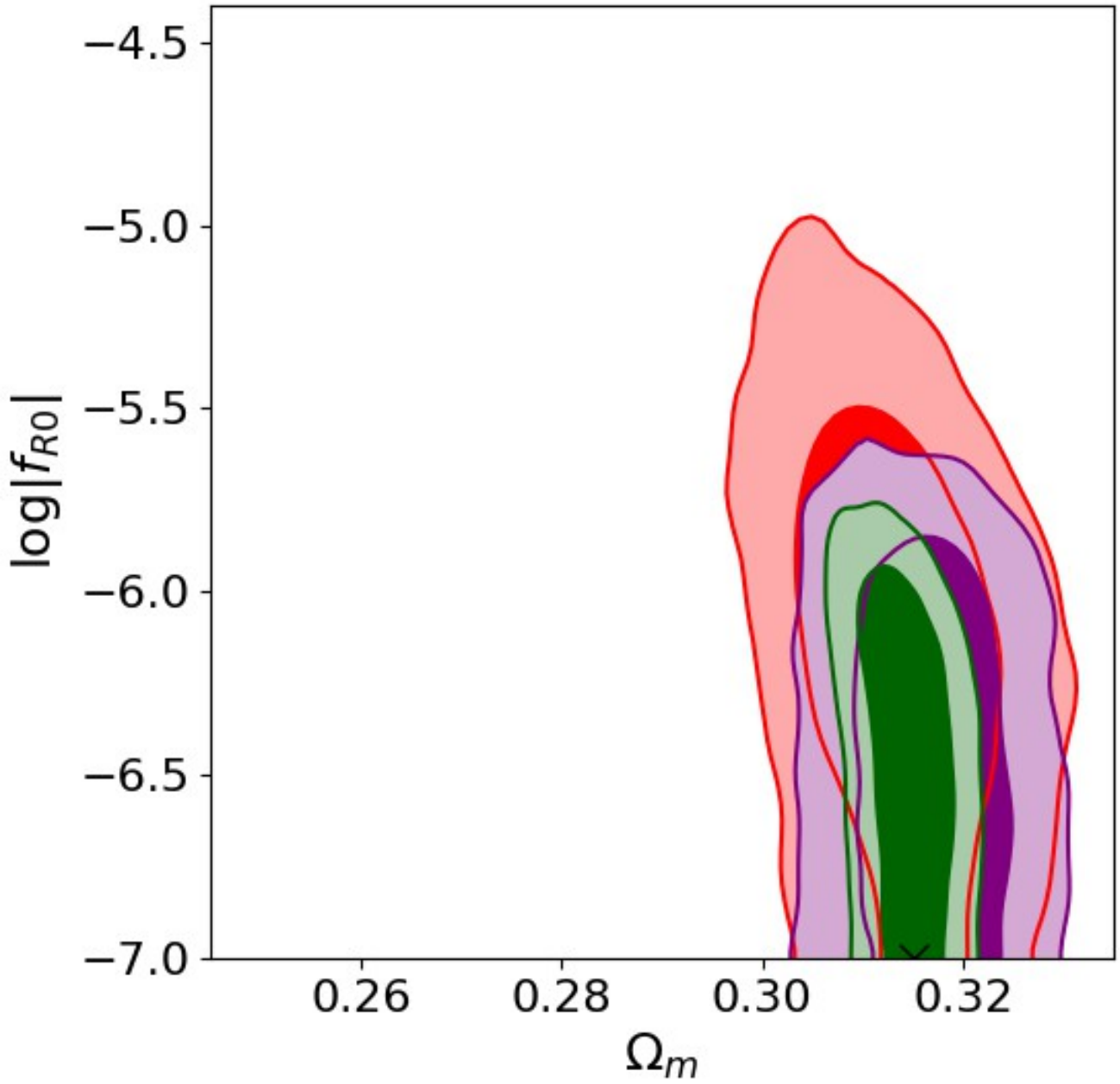

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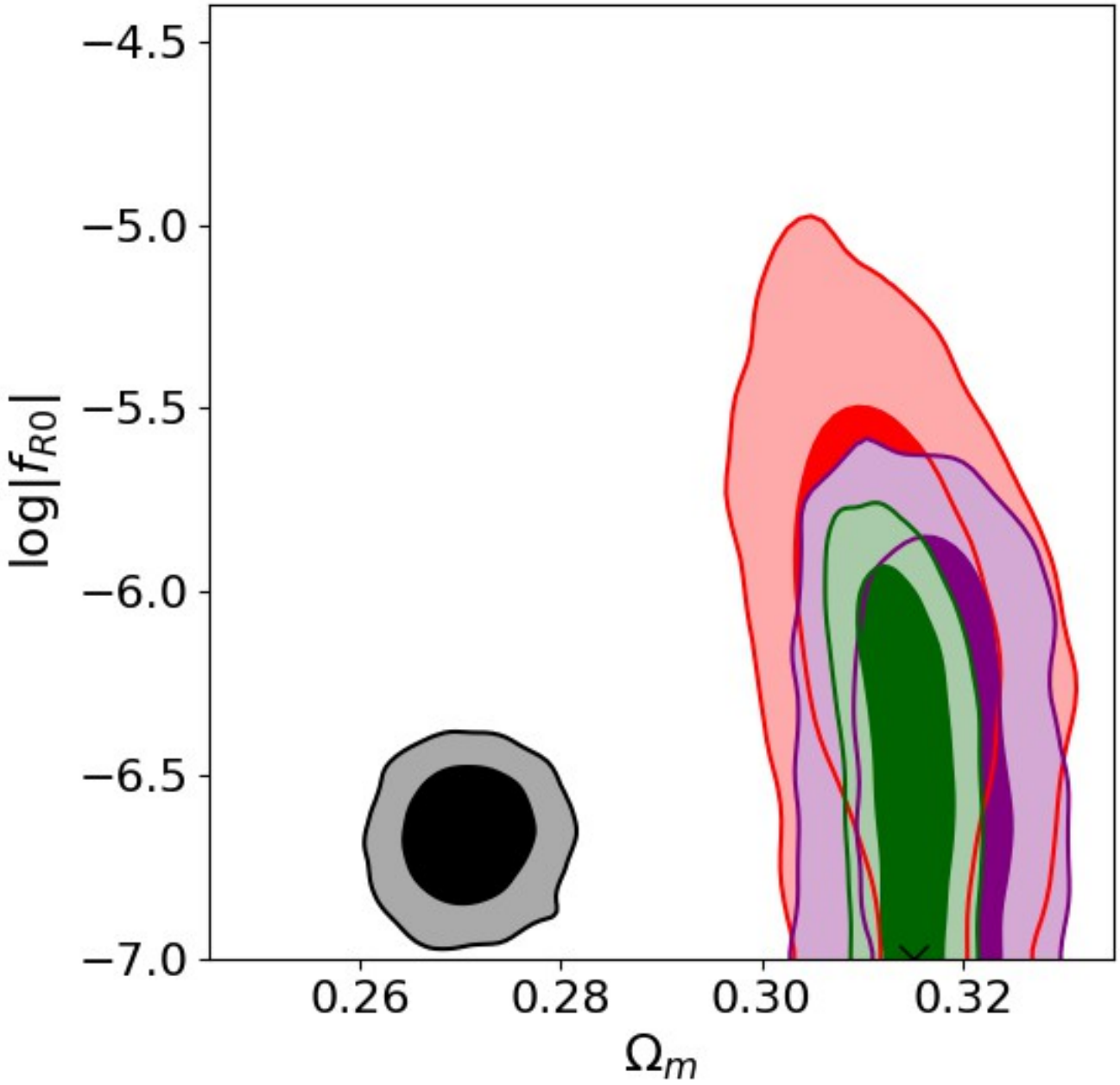
(no baryons)



Weak Lensing Forecast – Dark Matter

Mixed dark matter

MCMC param. inference

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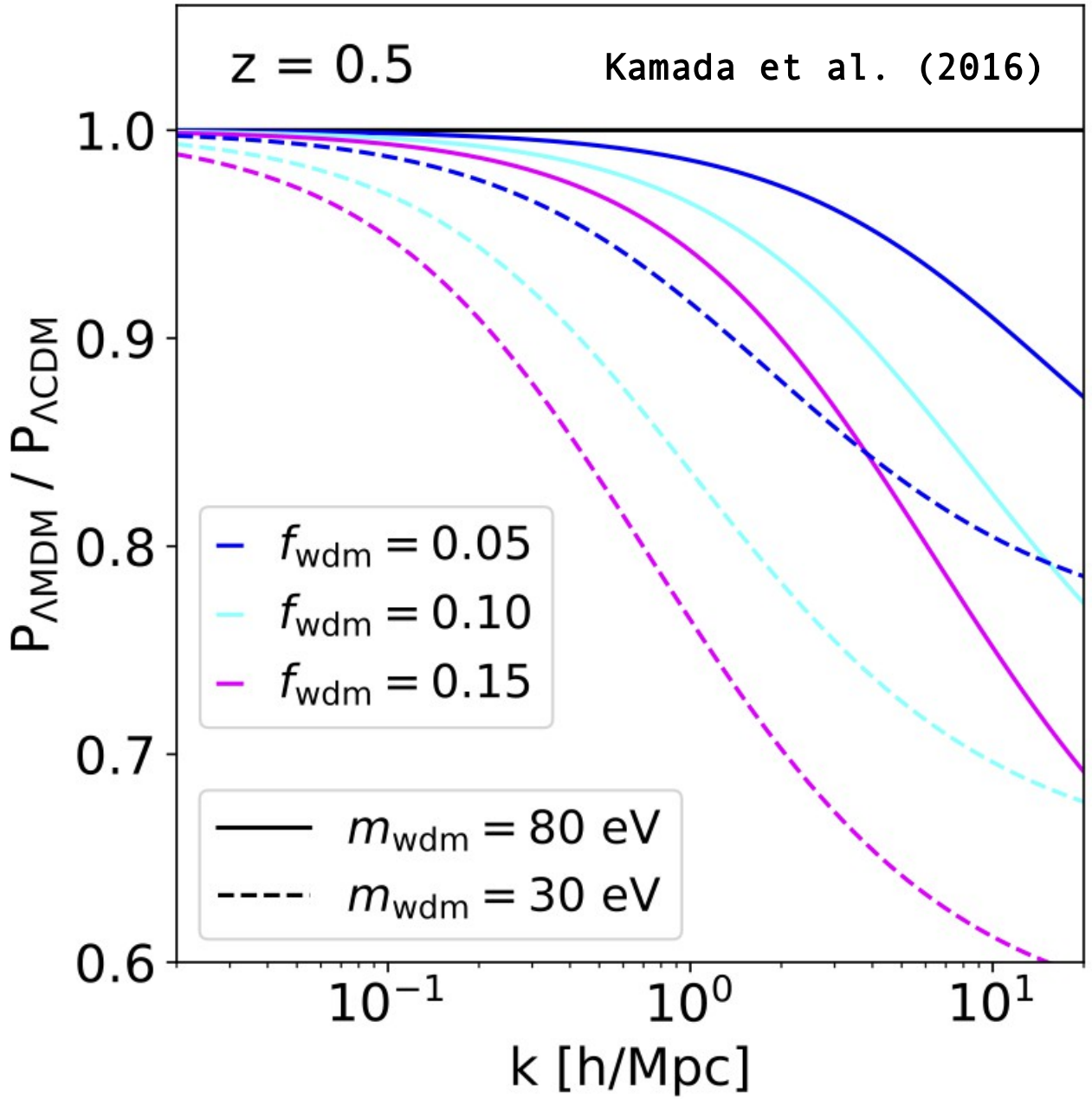

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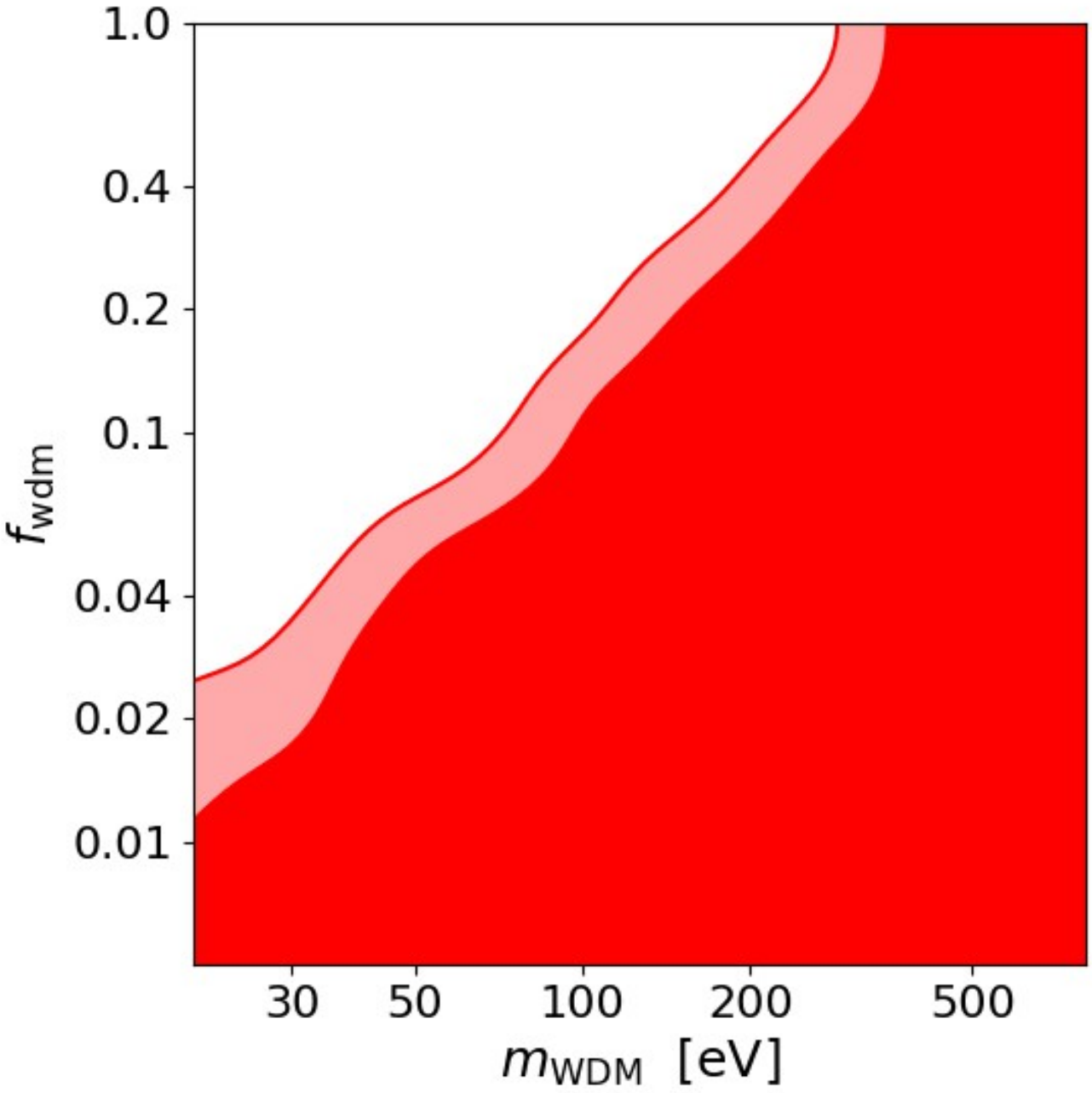

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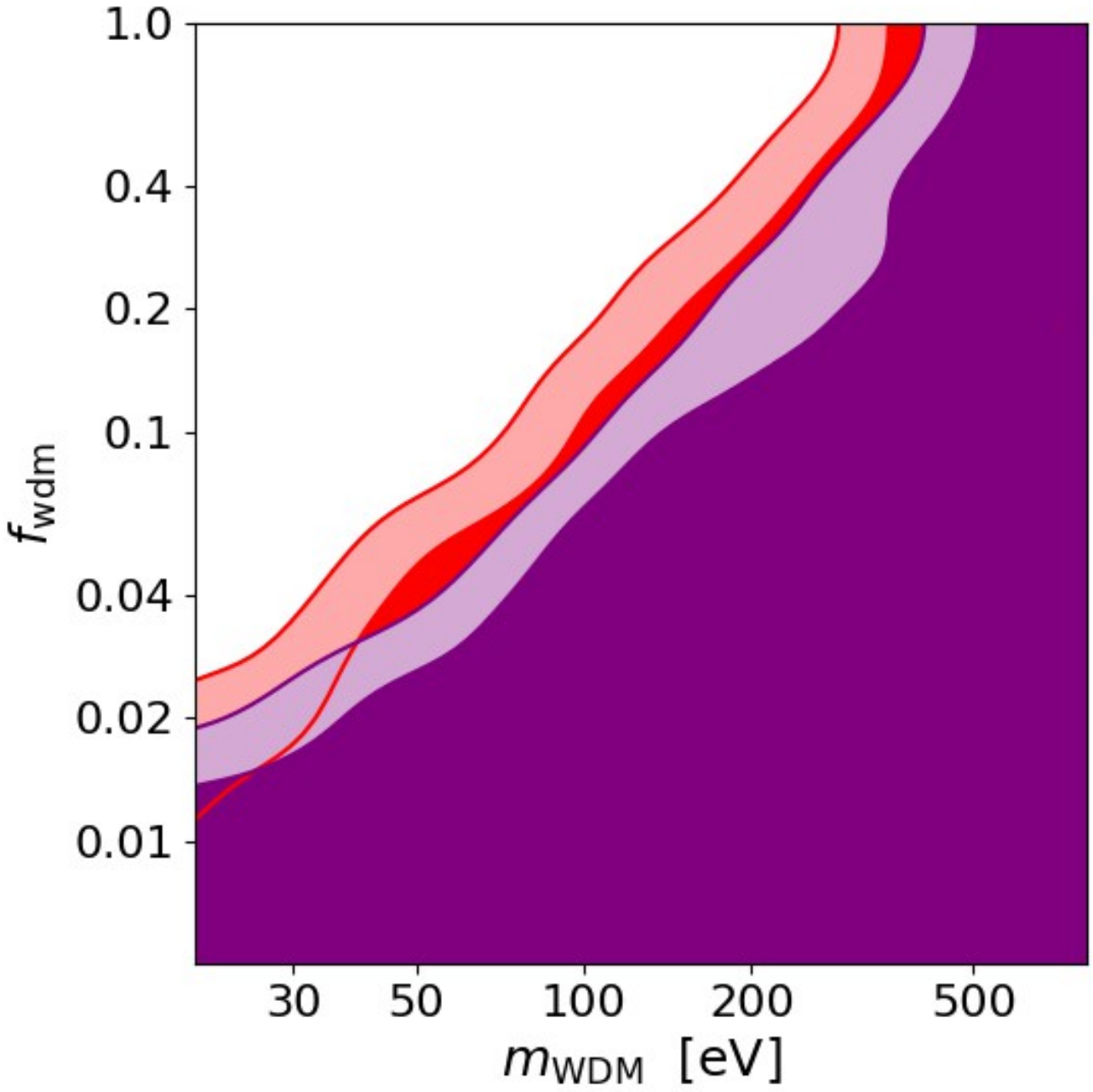
Cosmic shear + X-ray



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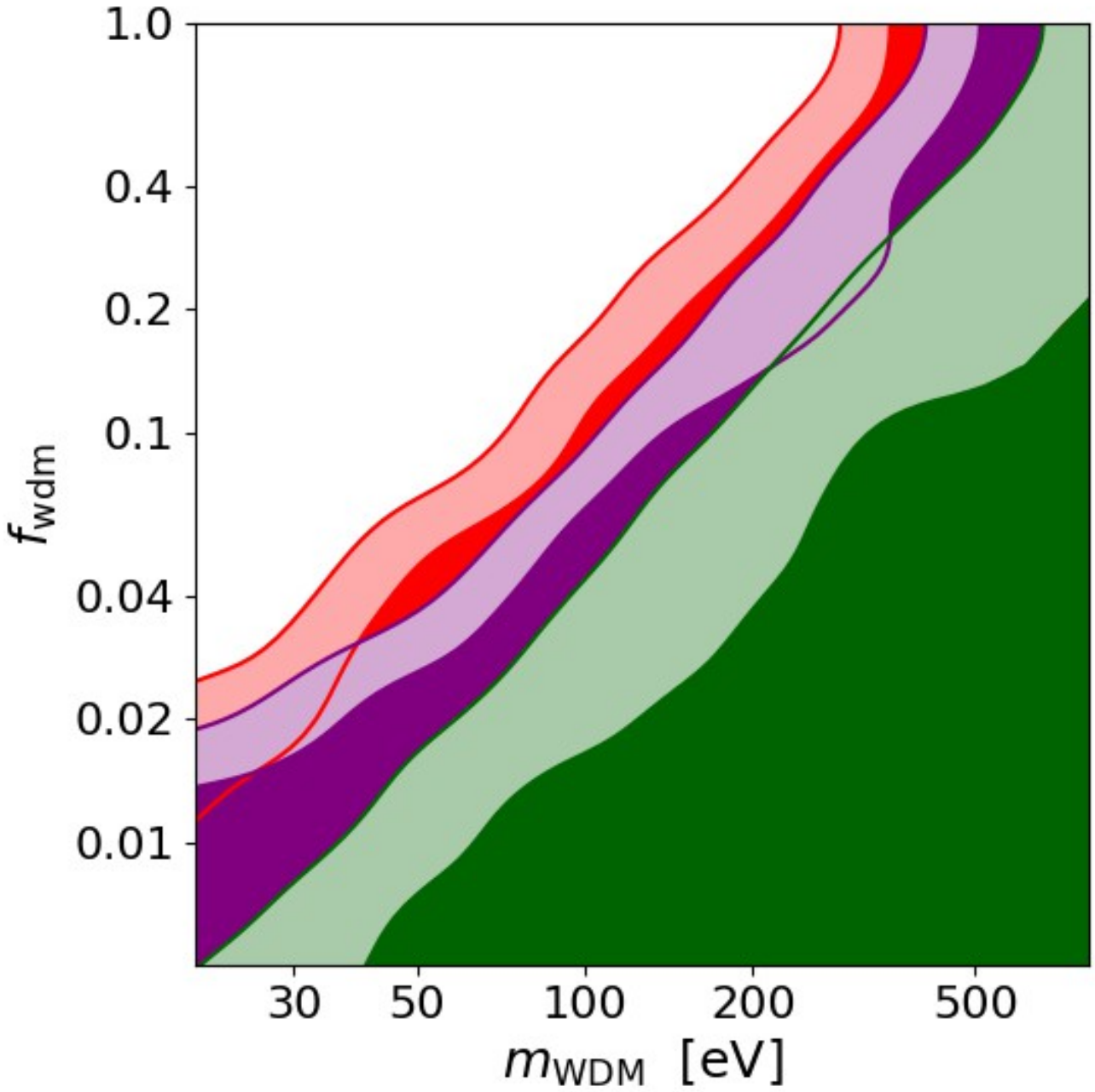

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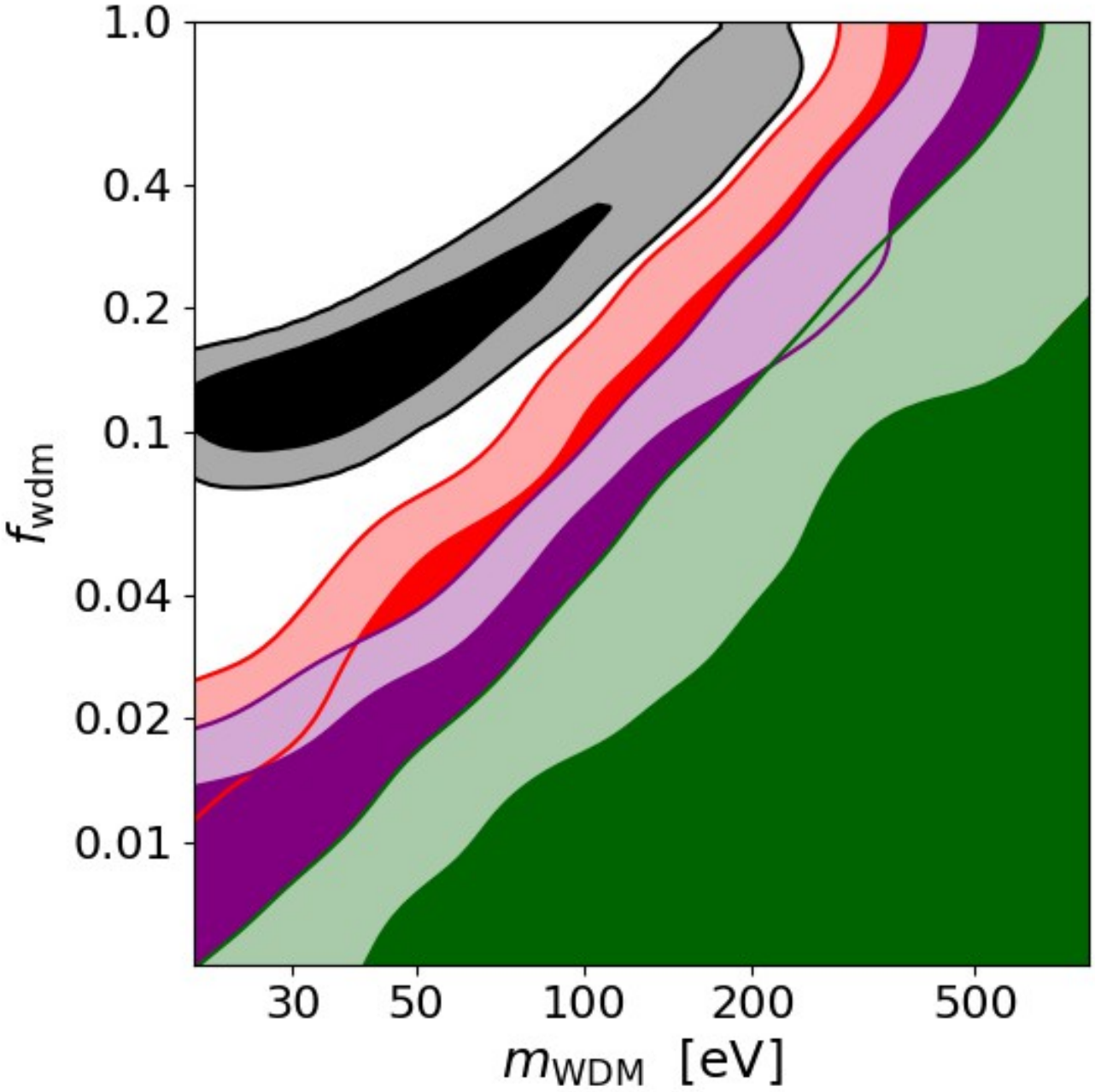
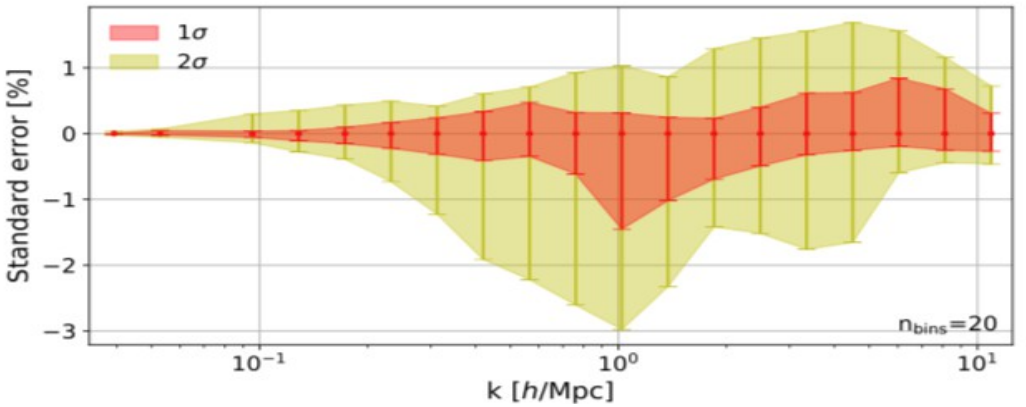


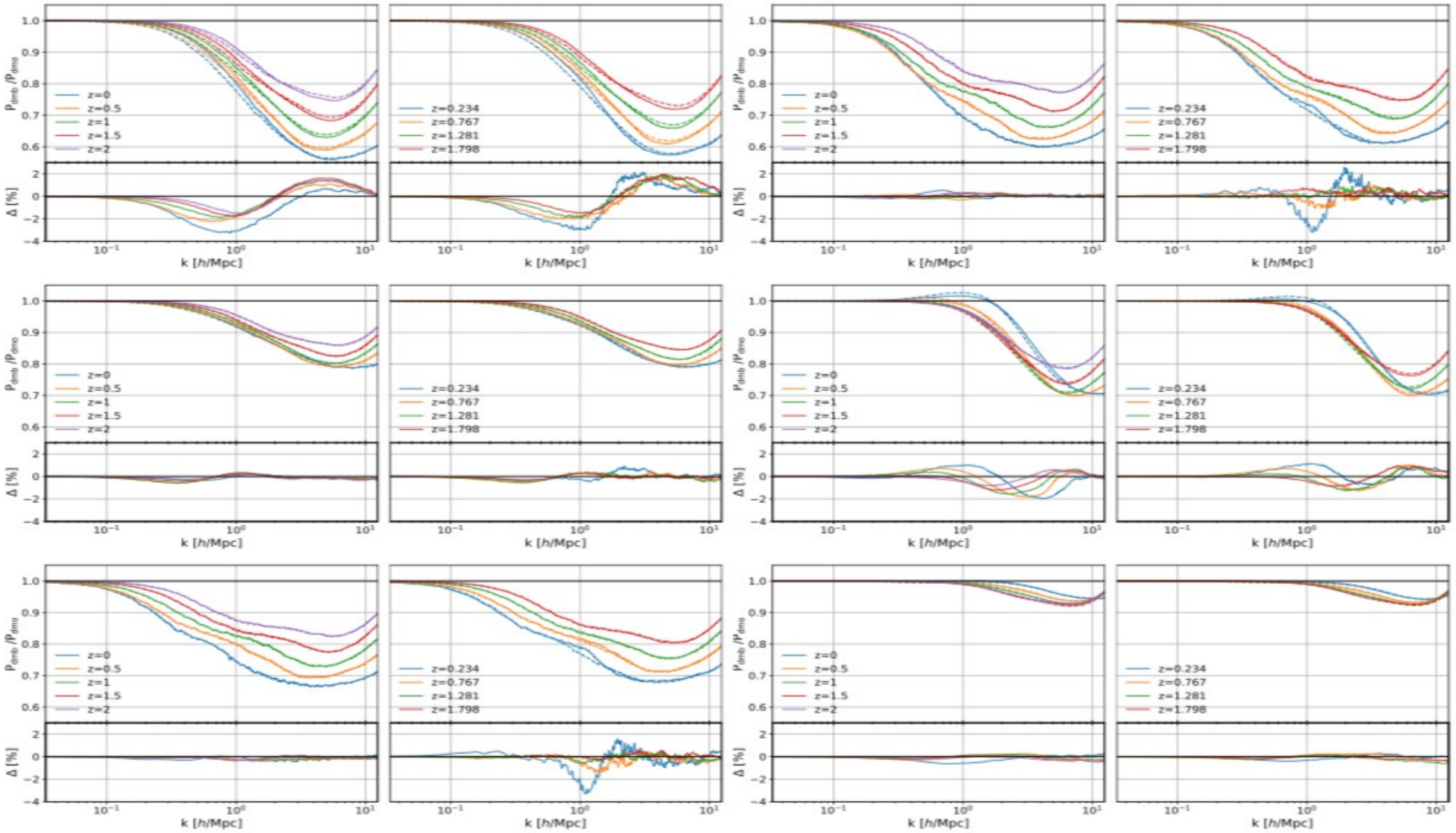
Conclusions:

- Parametrisation of baryonic effect is both necessary and sufficient to obtain tight constraints on cosmology!

- External X-ray data helps to further decrease errors (20-30 percent for LCDM, more for extended cosmologies)

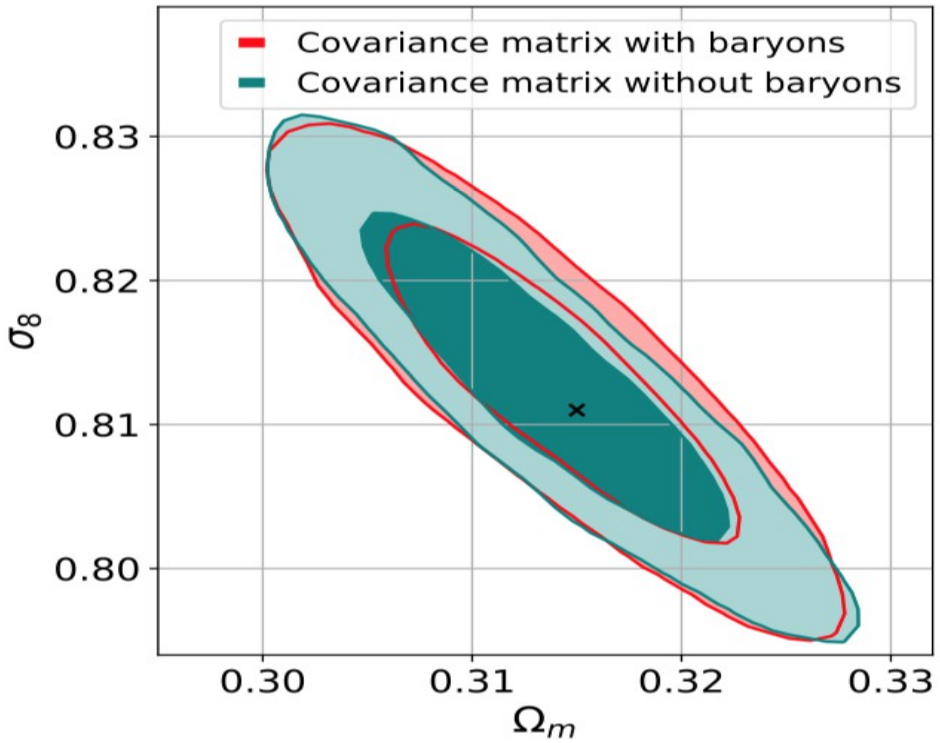
Baryonic Emulator

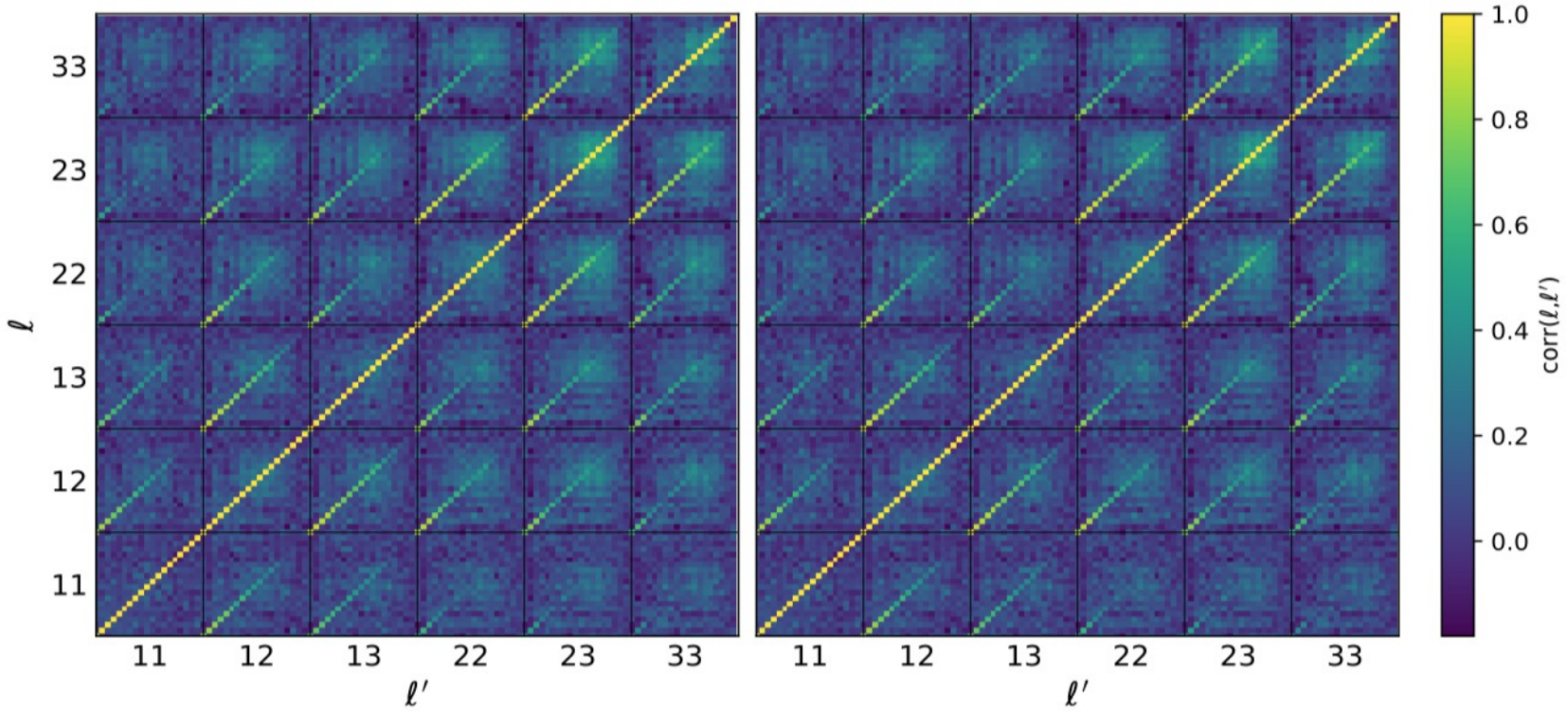




Covariance Matrix

(with and without baryons)





Cosmological dependence of baryonic effects