Clusters in LCDM

Alain Blanchard

From Z. Sakr, S.Ilić, A. Blanchard

Paris, October 25th, 2018

How to use clusters for Cosmology
(from clusters abundance)

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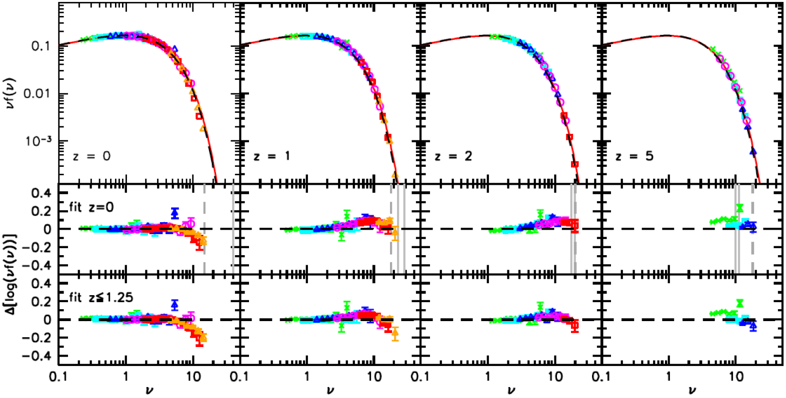
The mass function follows a scaling law:

$$n(M) = -\frac{\overline{\rho}}{M^2\sigma(M)}\delta_{NL}\frac{d\ln\sigma}{d\ln M}\mathcal{F}(\nu_{NL})$$

The beauty of the mass function...



Despali et al. 2015

The uggly real world...

Going from mass to observables

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- Xray scaling law

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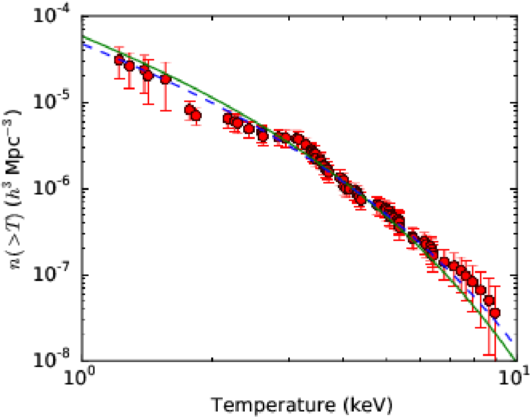
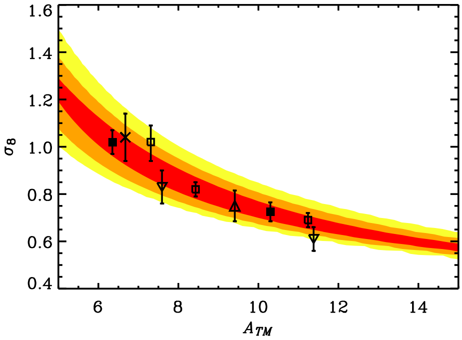
Fitting the X-ray temperature function at $z \sim 0.05$



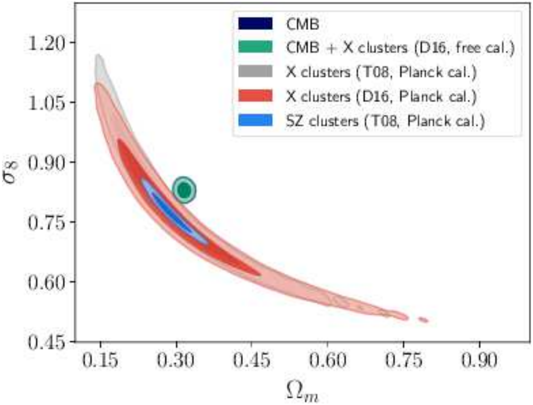
Ilic, Blanchard & Douspis 2015

Degeneracy on astrophysical parameters



Douspis & Blanchard 2005

The cluster-CMB tension (in ΛCDM)



No sign of systematics between x-ray clusters ($z \sim 0.05$) and SZ clusters ($z \sim 0.25$)

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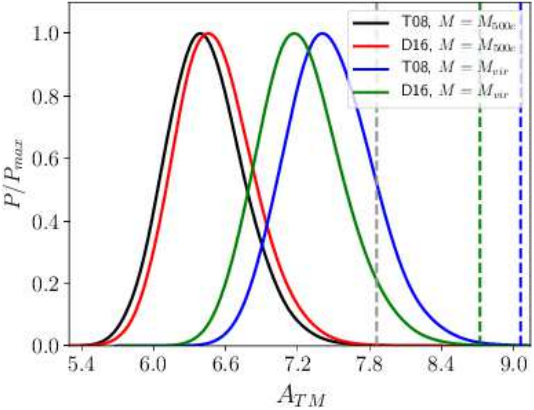
- No calibration, no tension...But infer the calibration!

How strong is the tension ?

X-ray



Sakr, Ilic & Blanchard(2018)

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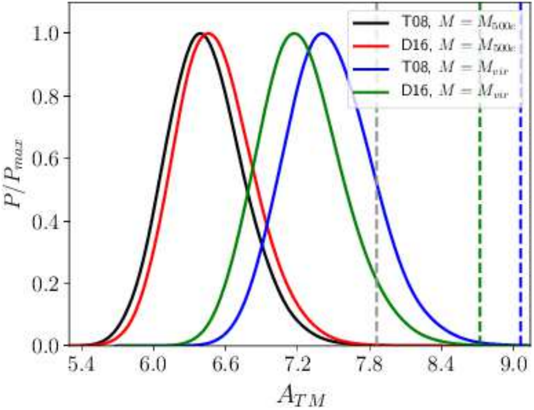

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From $\geq 4\sigma$ down to...

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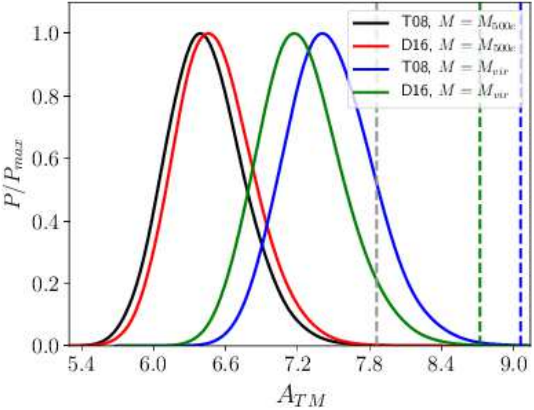

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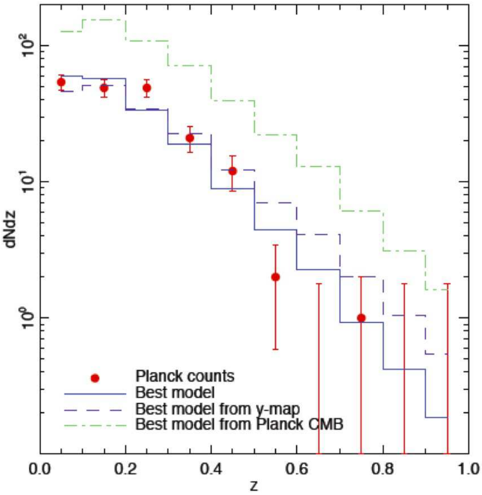

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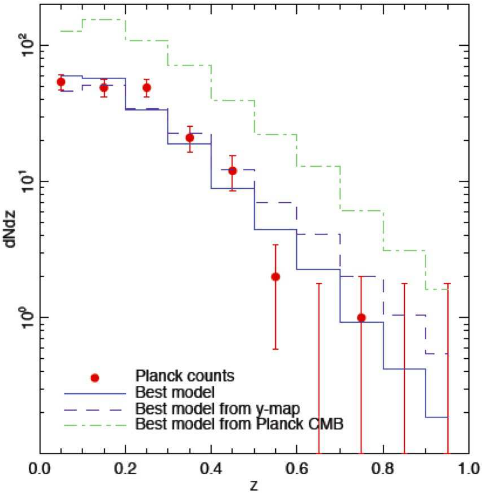

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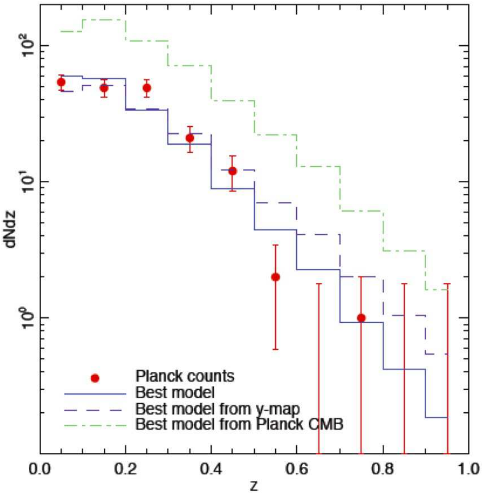

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SZ: $\approx 6\sigma$

What could be the solution?

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New physics

- Massive neutrinos (change $P(k)$, growth rate, ...)
- Modification in the gravitational sector (MG).

Effect of the presence of massive neutrinos

Mass function has to be modified (neutrino prescription)

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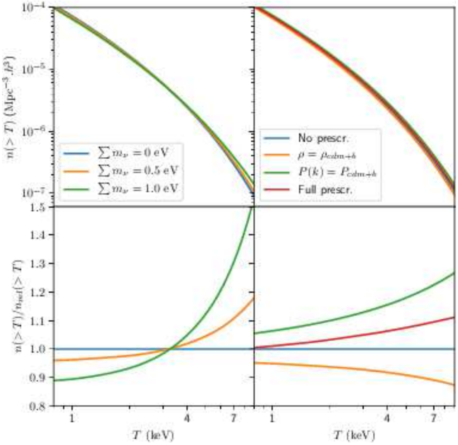

Effect of the presence of massive neutrinos

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Adding BAO (green), adding Lymanα (red), combined (grey)

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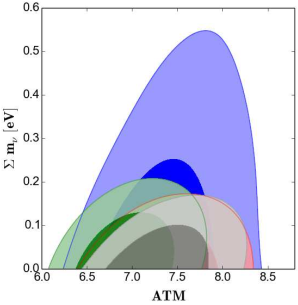

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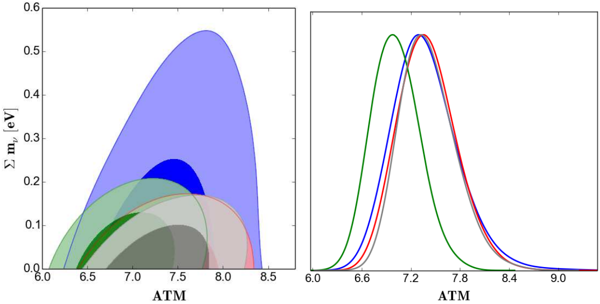

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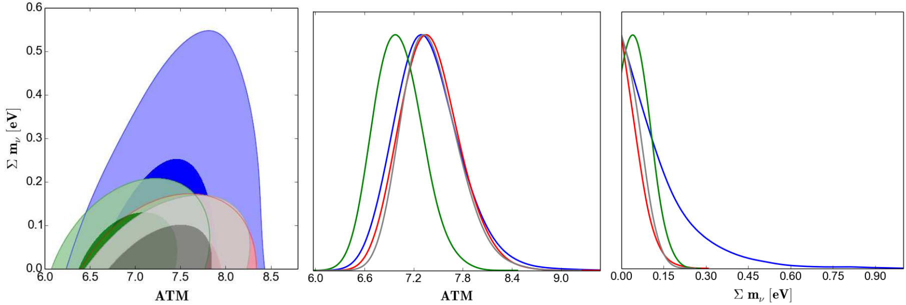

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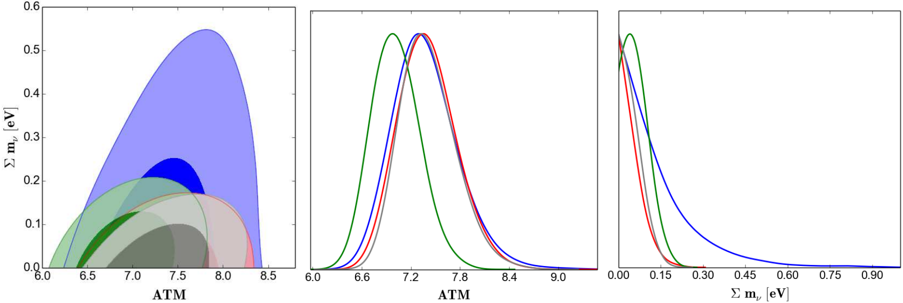

Massive neutrinos do not seem to help.

Modifying growth rate

X-ray

Growth rate with a γ parametrization.

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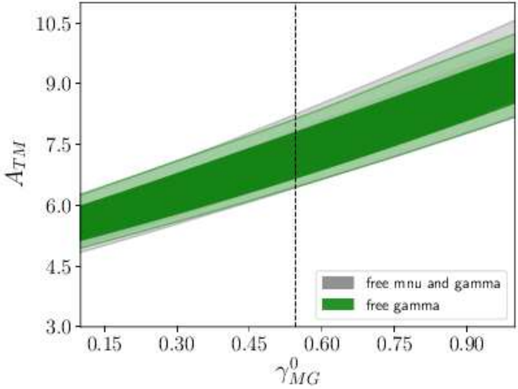

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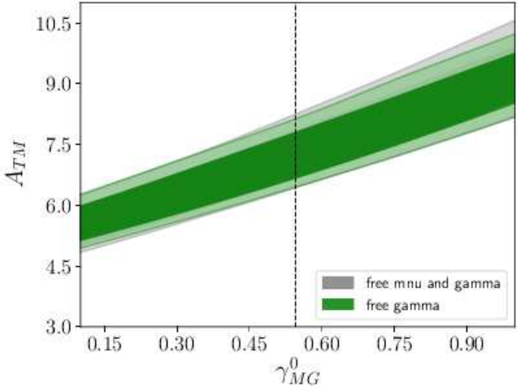

Robust correlation between γ and A_{TM}.

Final comparison (X-ray)

Planck CMB calibration versus Planck Clusters calibration

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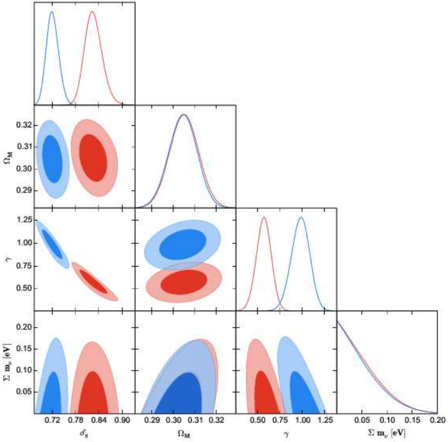

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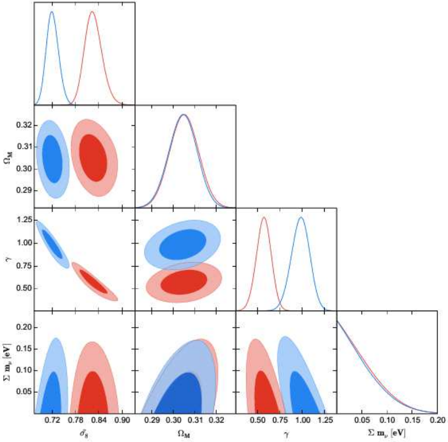

Planck cluster calibration if confirmed would favors MG...

Modifying growth rate & massive neutrinos

X-ray+SZ

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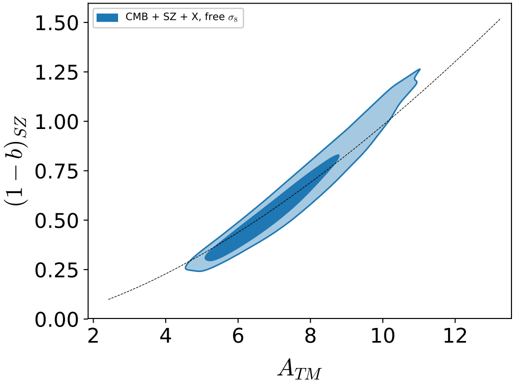

Ilic, Sakr & Blanchard(2018?)

Free σ_8

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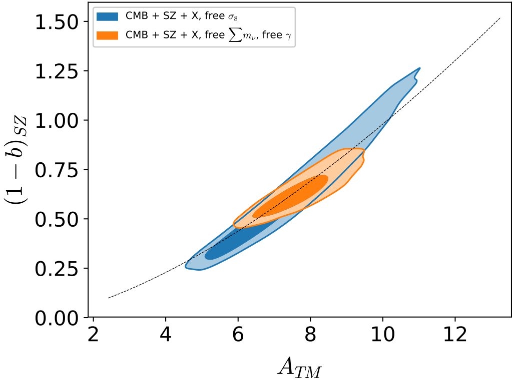

Ilic, Sakr & Blanchard(2018?)
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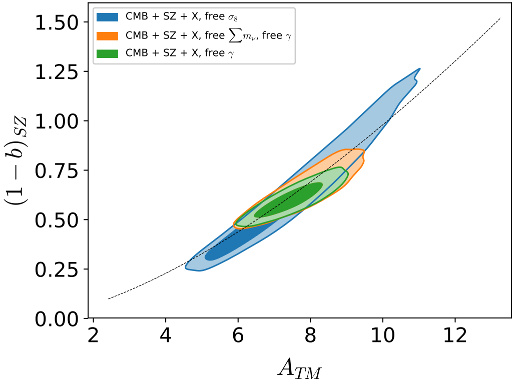

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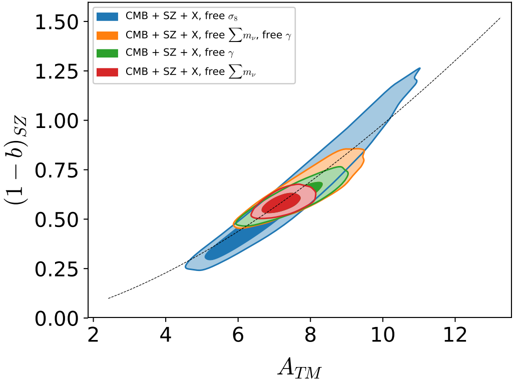

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Free Σm_ν

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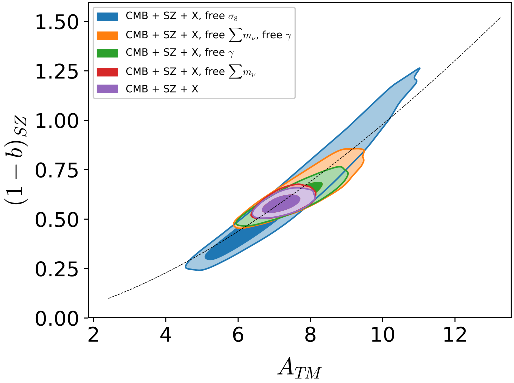

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LCDM

X-ray

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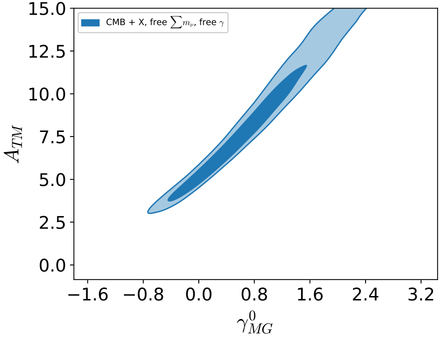

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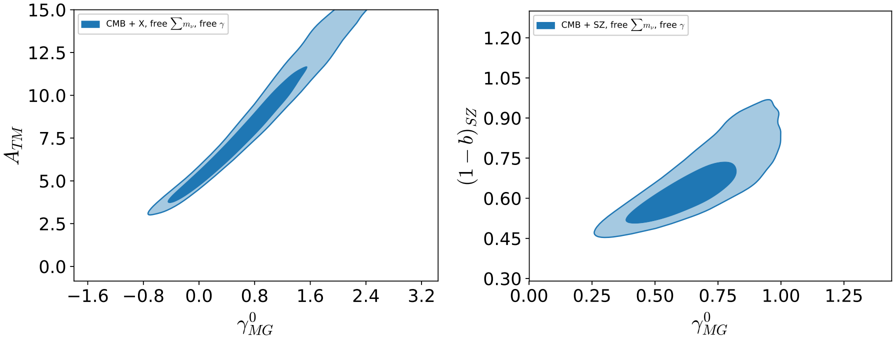

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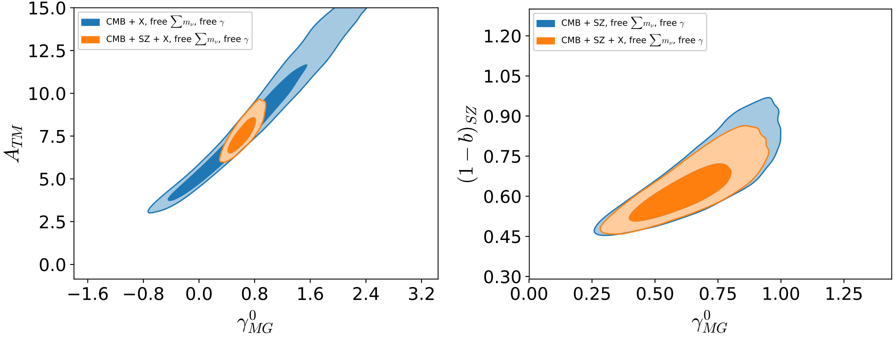

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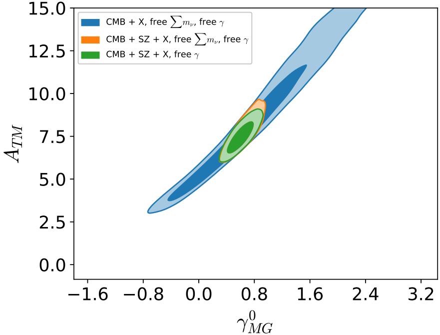

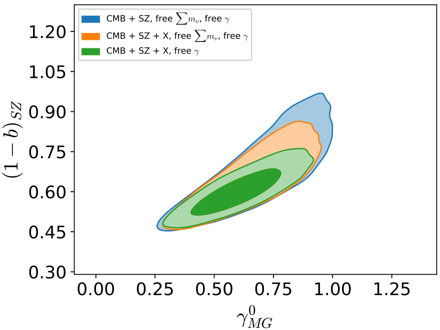

LCDM: $(1-b)_{SZ} = 0.58^{+0.029}_{-0.034}$

Conclusion : SZ versus X-ray

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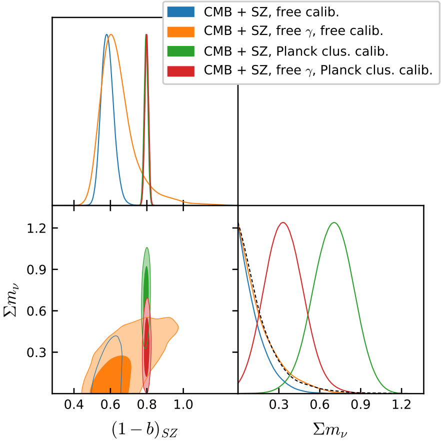

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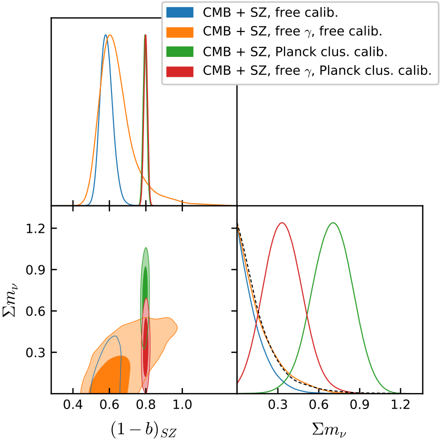

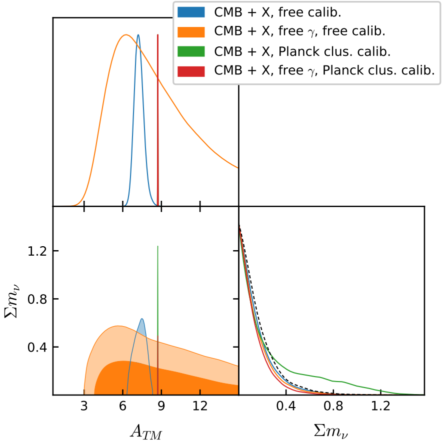

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