School of Astrophysics "Francesco Lucchin"
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SZ effect
&
cosmological parameter estimation.

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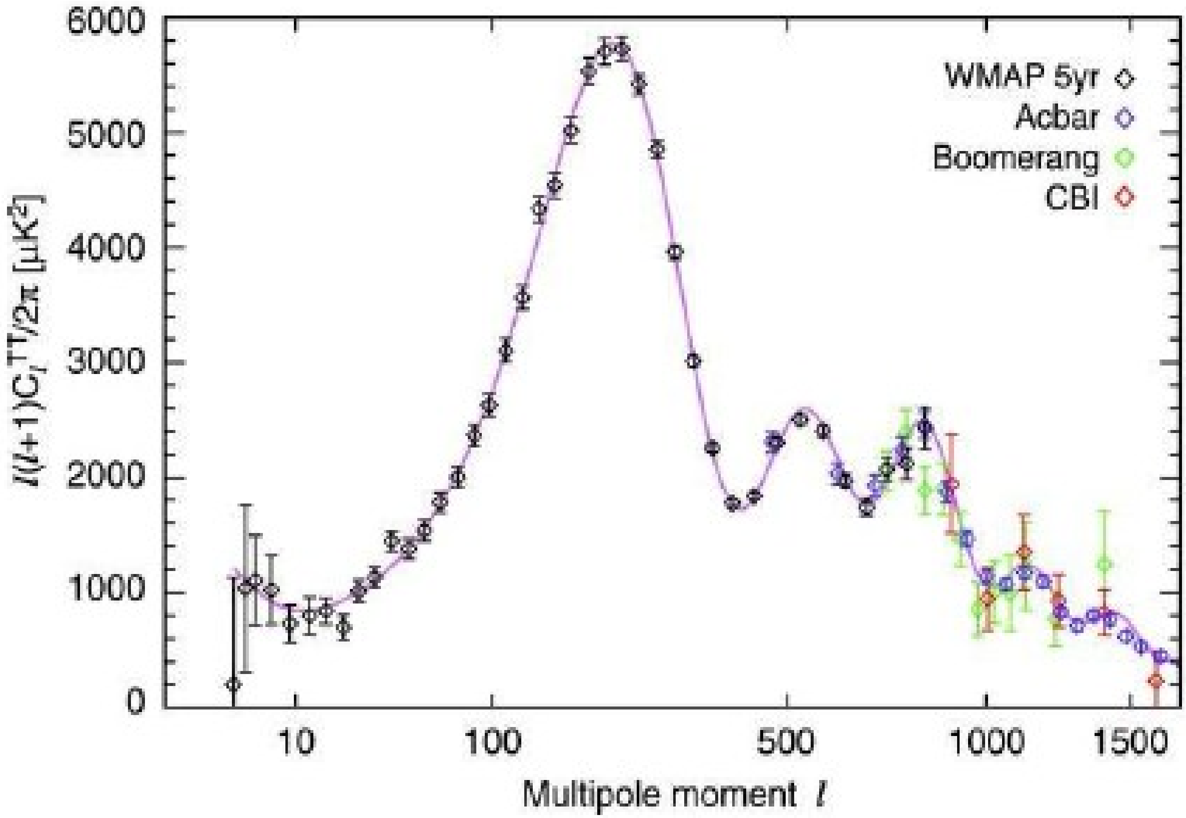
Context

- Large scale temperature and polarisation CMB observations => concordance model



Nolta et al., 2009

⇒ exquisite precision (a few percent) on the cosmological parameters values e.g.
$n_s = 0.963 \pm 0.014$ (Dunkley et al., 2009)

- Complementary experiments are observing anisotropies at small scales : excess power in respect to primary CMB.

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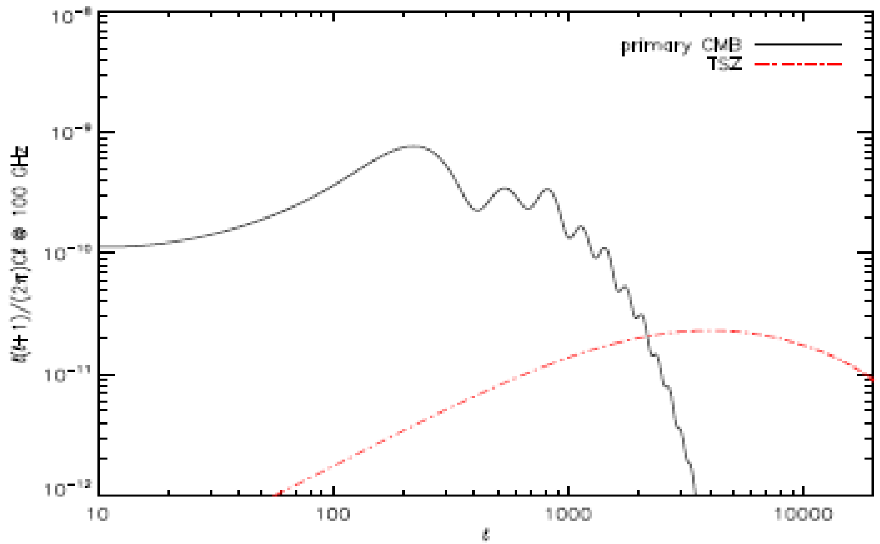
Secondary anisotropies affect the primary CMB

- Gravitationnnal effects
- Scattering effects



Thermal SZ main contribution at small scales and dominates over primary CMB above $\ell \simeq 2500$

How to deal with this SZ signal ?

Different approaches can be considered :

- Fit the total signal with $C_\ell^{\mathrm{CMB}} + C_\ell^{\mathrm{SZ}}$
- Remove SZ contribution of detected clusters $\Rightarrow$ left with residuals

I studied the 2^{nd} approach in order to determine if it is a valuable method.

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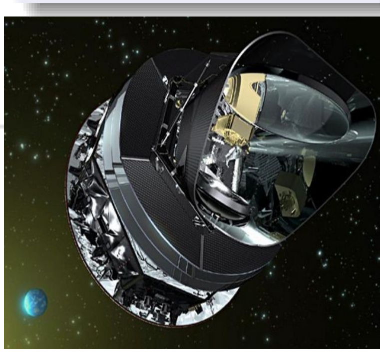
Large upcoming **multifrequency surveys** (Planck, SPT...)



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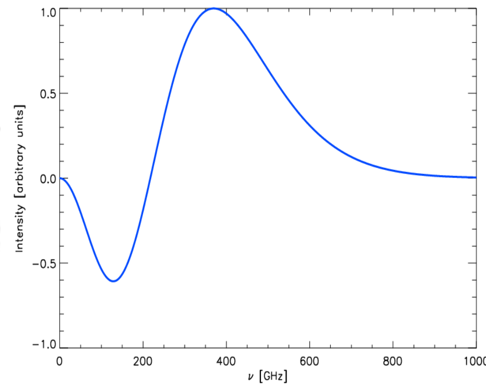
galaxy clusters **typical SZ spectral signature**



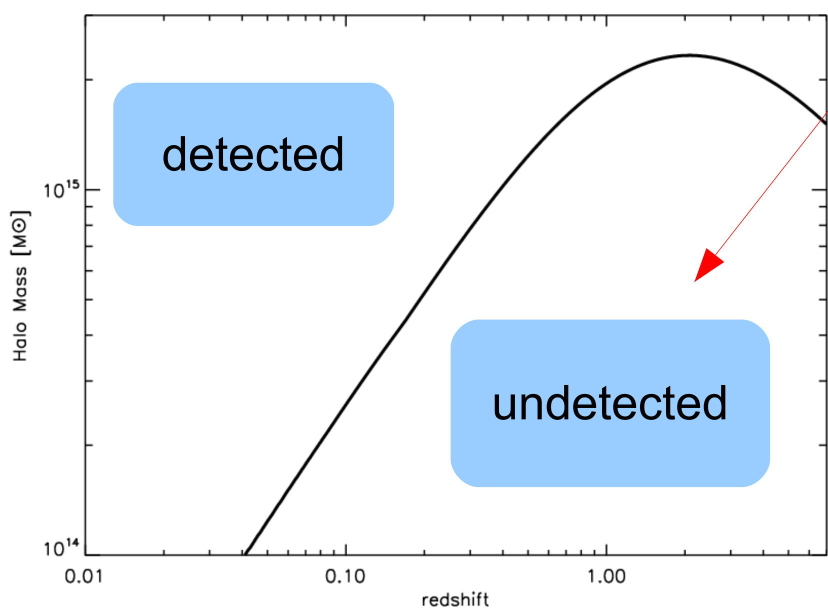
⇒

detection of galaxy clusters ⇒ build up **SZ cluster catalogues**

SZ residuals

Are these residuals a problem ?

The theoretical SZ selection function



=> **selection function**
minimum mass of a cluster,
as a function of z, to be detected

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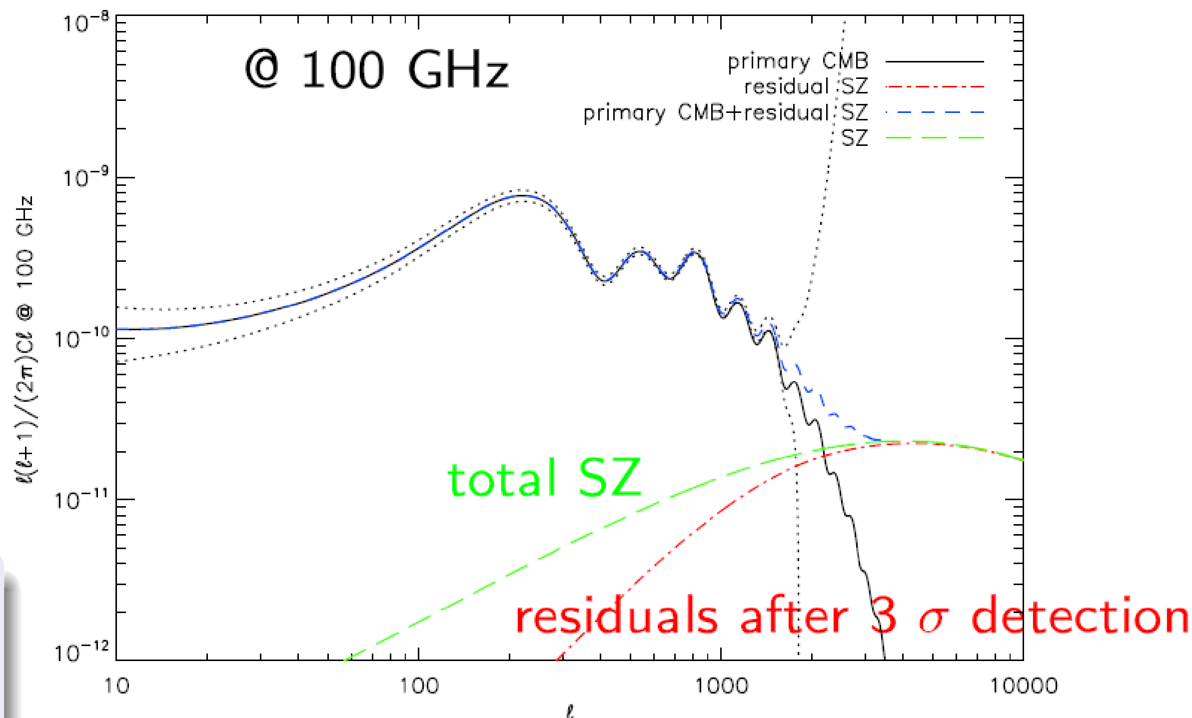
The TSZ residuals angular power spectrum

The poissonian contribution to the TSZ angular power spectrum writes **(Komatsu & Seljak, 2002)** :

$$C_\ell = f_\nu^2 \int_0^{z_{\rm dec}} dz \frac{dV}{dz} \int_{M_{\rm min}}^{M_{\rm max}} dM \frac{dn(M,z)}{dM} |\tilde{y}(M,z)|^2$$

It thus depends on the cosmology and the distribution of the intra-cluster gas.

- $M_{\rm max} = M_{\rm lim}(z)$ (from selection function) to calculate the residual TSZ angular power spectrum



Massive and low z clusters removed : quite a lot of residuals. What is their impact ?

⇒ general method for bias calculation

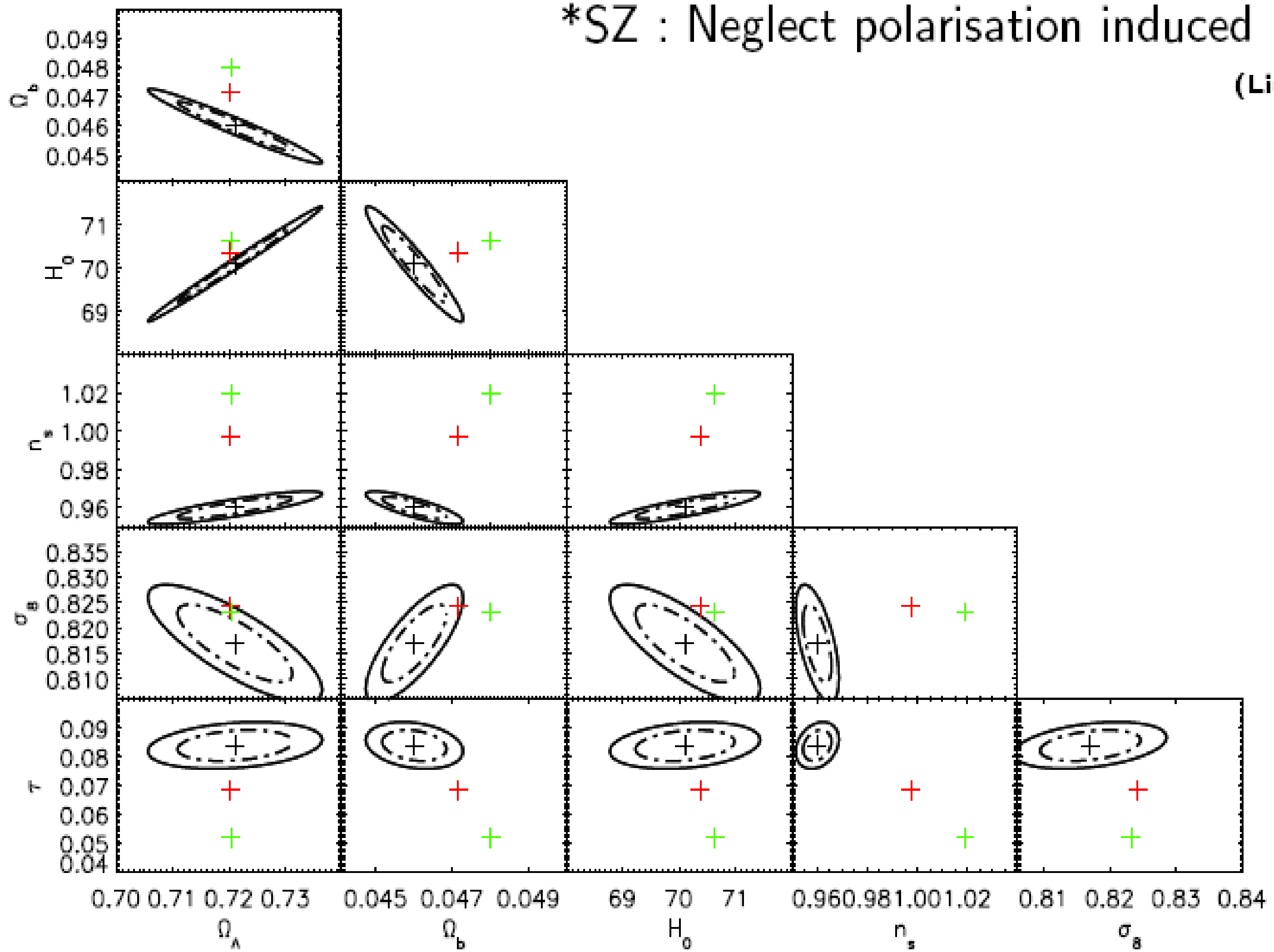
Taburet et al., MNRAS, 2009, 392, 1153

Biases on cosmological parameters due to TSZ residuals

*CMB : TT, EE and TE. *Planck* @ 100 GHz

*SZ : Neglect polarisation induced by galaxy clusters

(Liu et al. 2005)



68.3% joint confidence regions. Black : reference model

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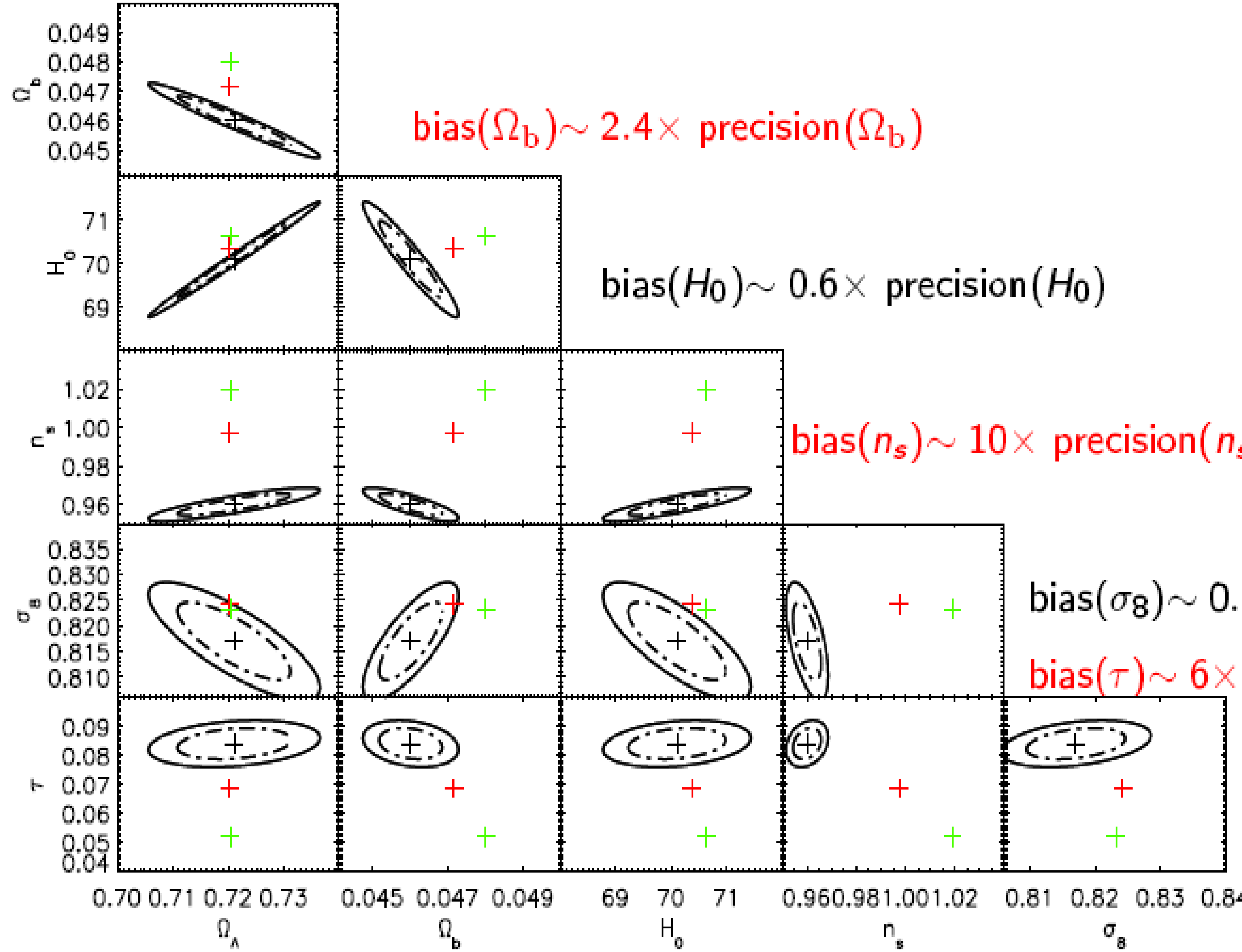
Biases on cosmological parameters due to TSZ residuals

bias(Ω_Λ)$\sim$ 0.1$\times$ precision(Ω_Λ)



bias(Ω_b)$\sim$ 2.4$\times$ precision(Ω_b)

bias(H_0)$\sim$ 0.6$\times$ precision(H_0)

bias(n_s)$\sim$ 10$\times$ precision(n_s)

bias(σ_8)$\sim$ 0.8$\times$ precision(σ_8)

bias(τ)$\sim$ 6$\times$ precision(τ)

68.3% joint confidence regions. Black : reference model, Red and Green : biases induced by the TSZ residuals after a 1σ and 5σ detection threshold.

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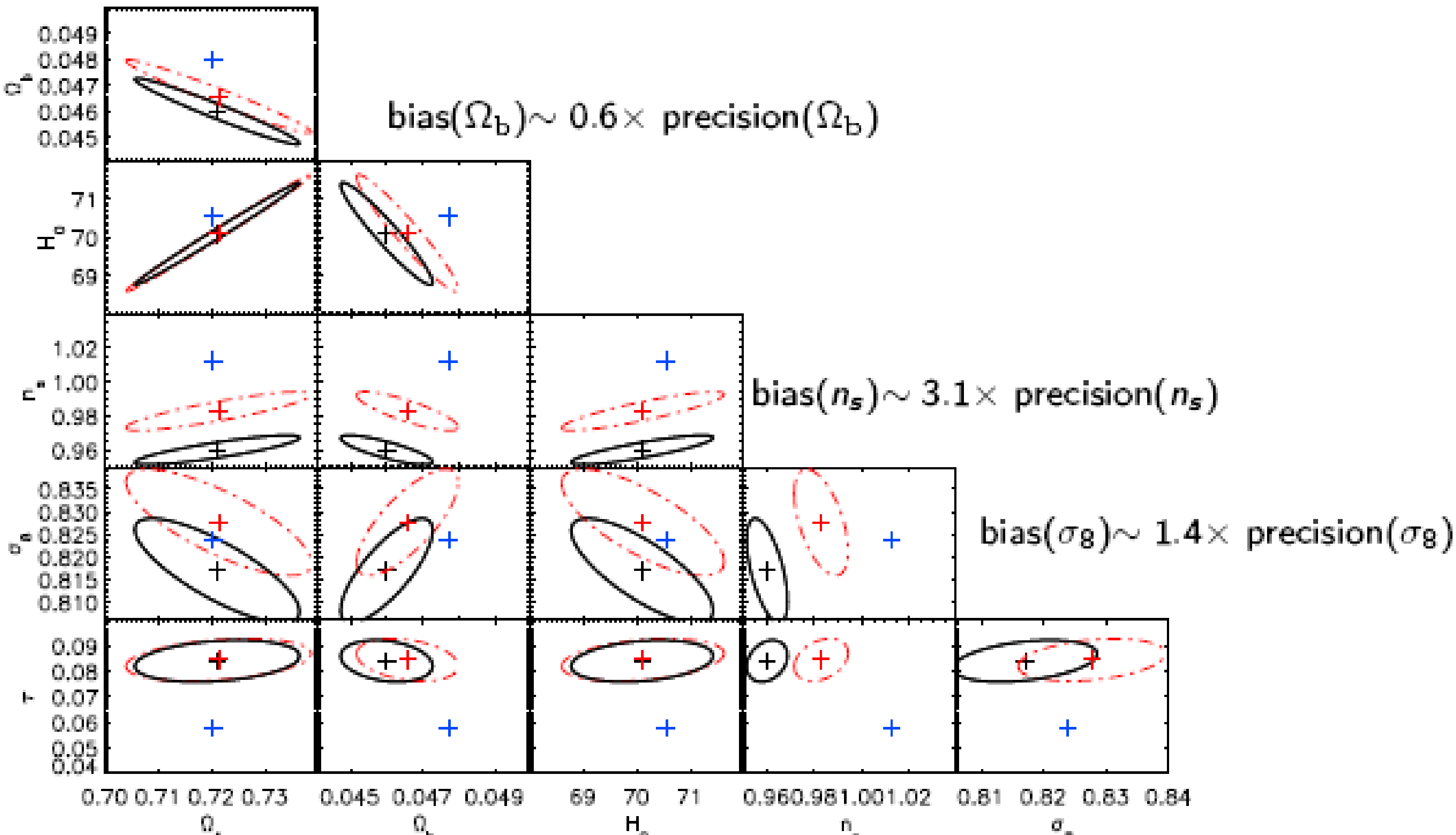
Conclusions :

- Exact and analytical method to calculate biases induced by any additive signal (astrophysical or systematics)
- **residuals in CMB analysis ⇒ significant biases on Ω_b and particulary n_s and τ**
  Planck : several times the expected accuracy on these parameters !

Ongoing work :

- SZ not only a contaminant : use it to constrain gas physics
- consistent analysis CMB + secondary anisotropies Taburet et al., in prep

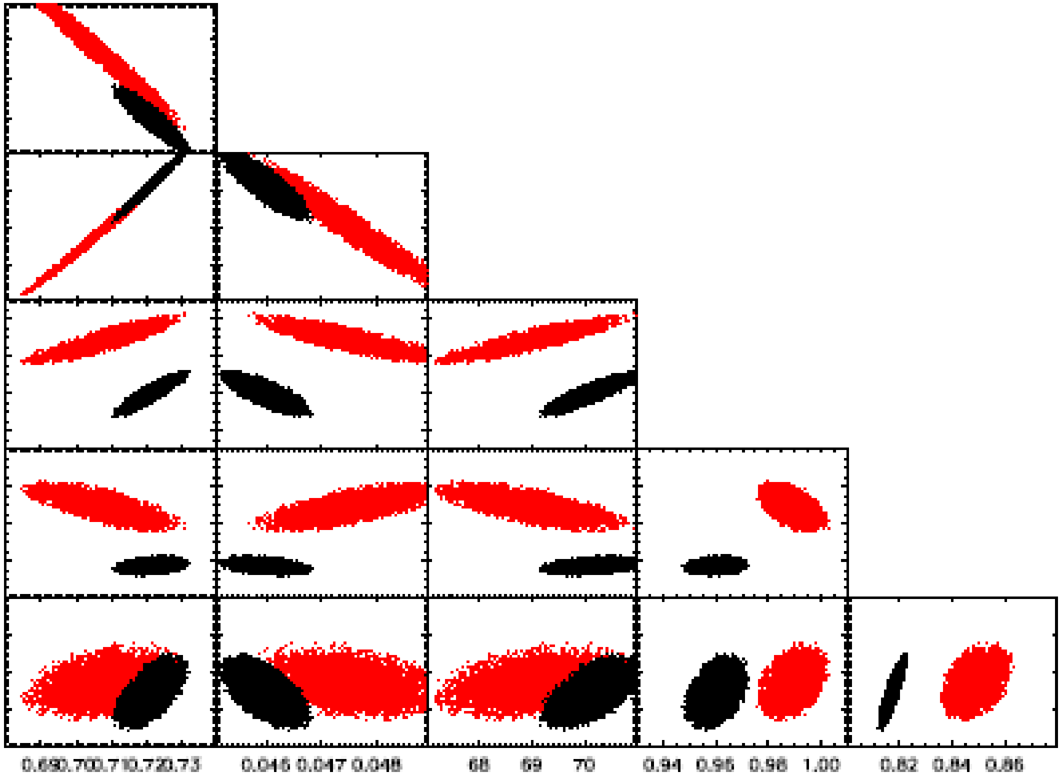
Cut TT spectrum at $\ell = 1000$ for parameter estimation ?



68.3% joint confidence regions. Black : reference model, Blue : biases induced by the TSZ residuals after a 3σ detection. Red : biases and accuracy degradation induced by the TSZ residuals after a 3σ detection and cut TT at $\ell = 1000$.

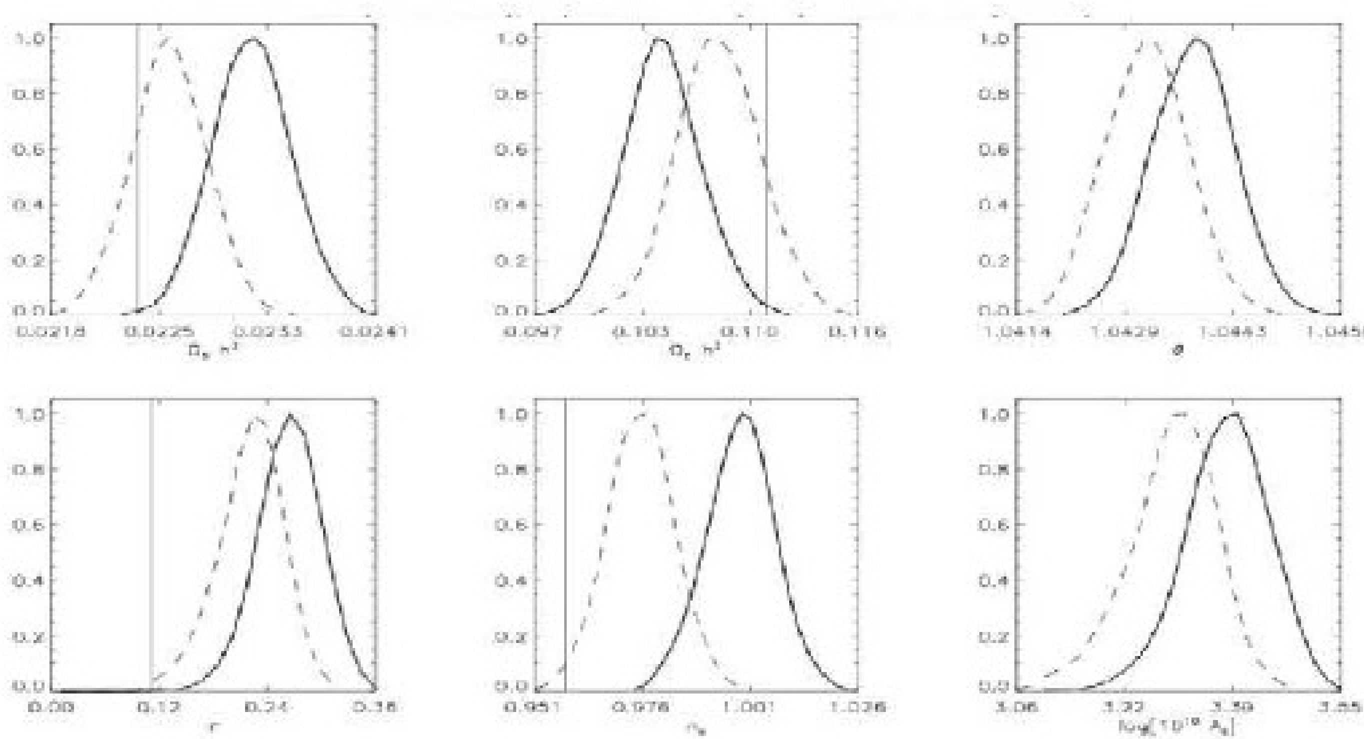
Cut TT spectrum at $\ell = 1000$ for parameter estimation ?

Check previous results with MCMC.



Black : CMB+SZ fitted with CMB+SZ. Red : biases induced by TSZ and accuracy degradation due to TT cut at $\ell = 1000$

- Component separation to remove SZ contribution. problem : not perfect : still residuals (filaments...)



CosmoMC + residuals from Planck WG2 challenge component separation
from J-A Rubino-Martin