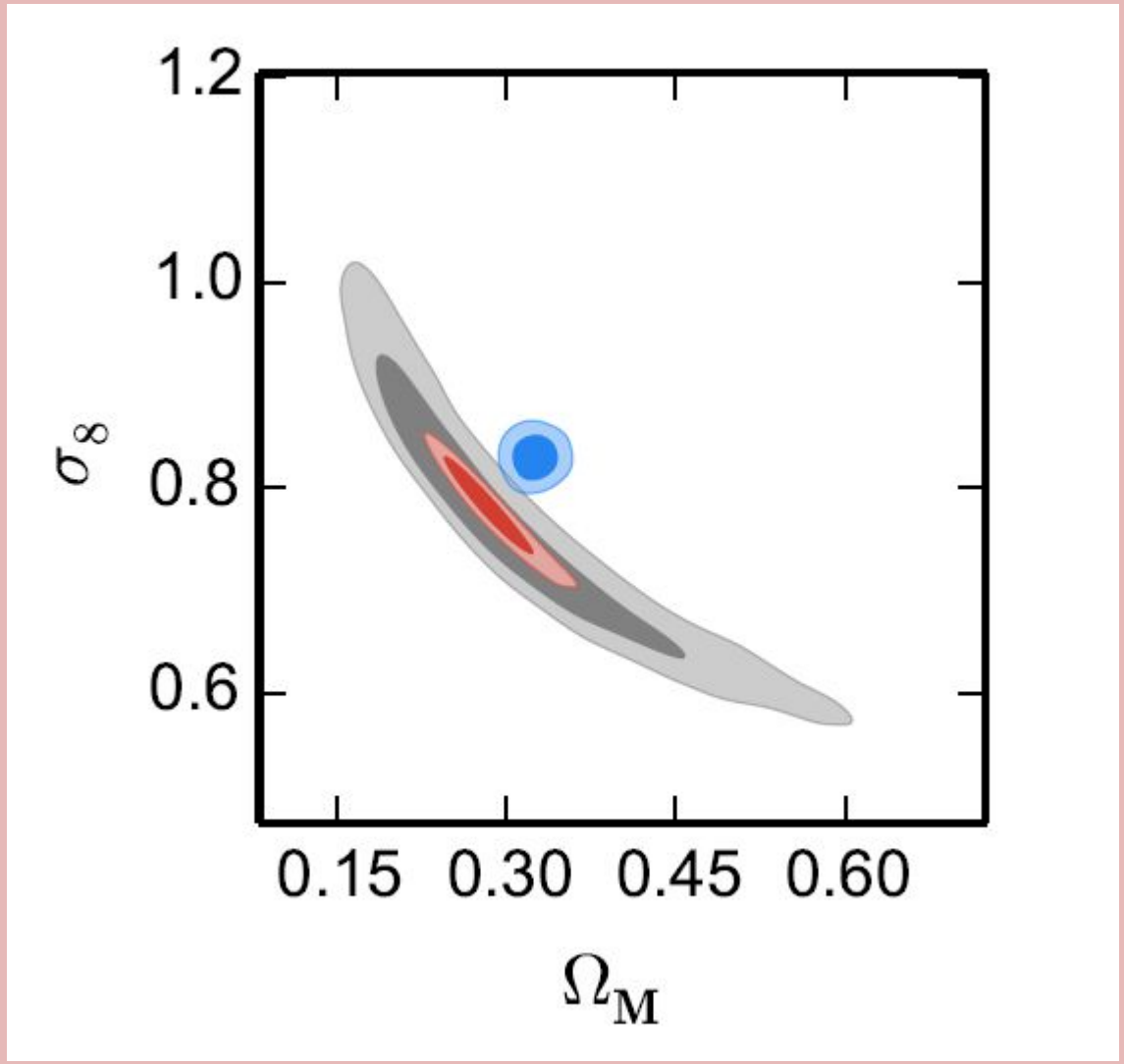
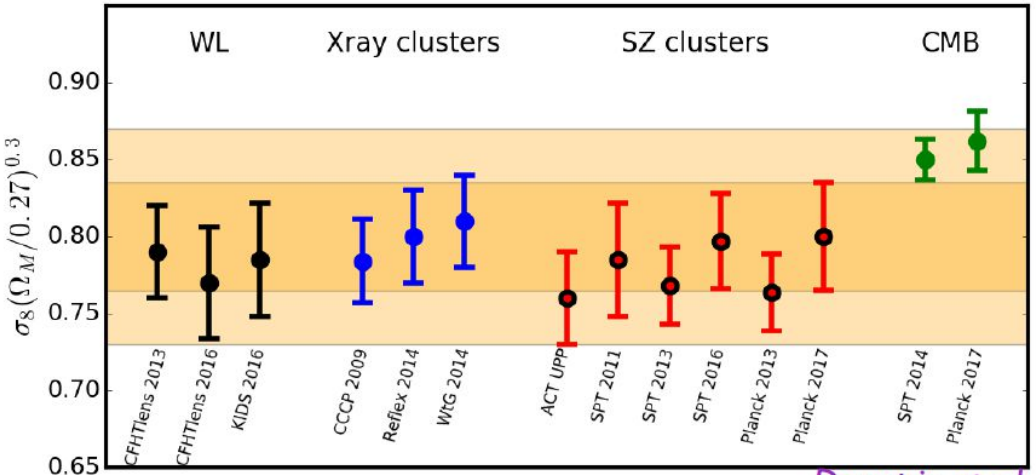
DE vs MG effect on Cluster Counts discrepancy

Z. Sakr with S. Ilic and A. Blanchard

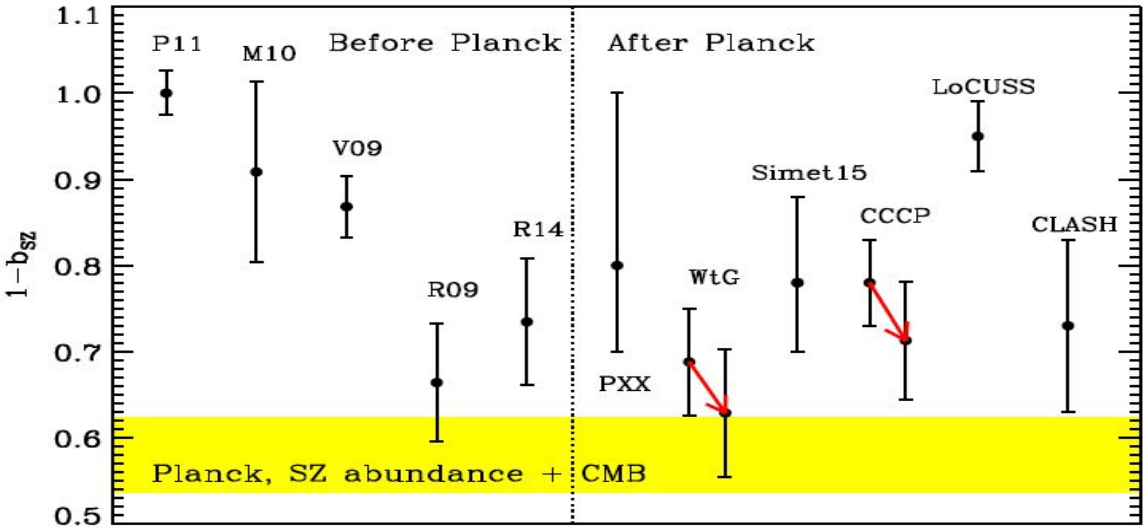
Dark Energy Action - July 2018


1.2
1.0
0.8
0.6
σ_8
0.15
0.30
0.45
0.60
Ω_M

.....is this tension real..... ?

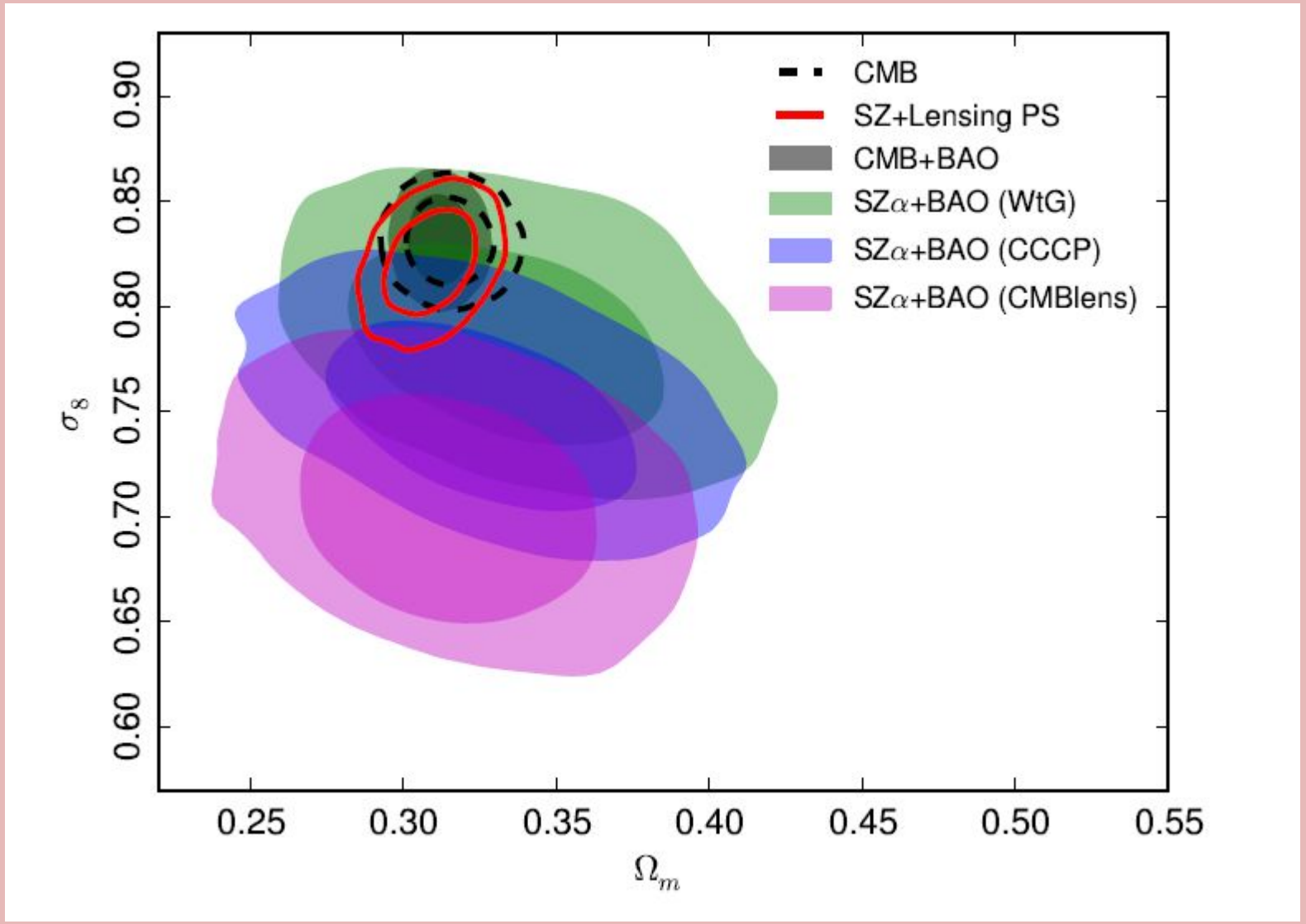


Douspis et al.



Penna lima 2017

.....is this tension real..... ?

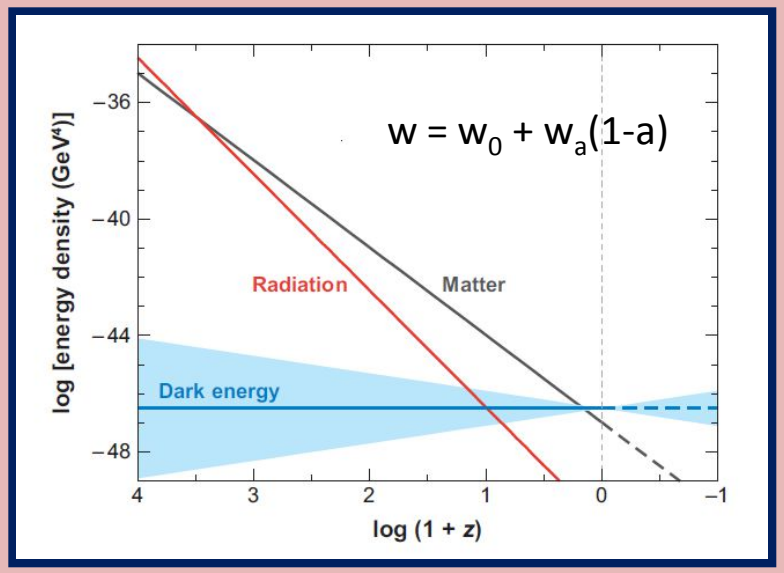


***Planck* SZ 2015**

Galaxy Cluster Counts

N(z,>M) = Mass Observable relation x voL x HMF

$$\frac{d^2N}{dz d\ln M} = \underbrace{A_{\rm survey}\frac{c}{H(z)}\left(\int_0^z dz'\frac{c}{H(z')}\right)^2}_{\text{volume}}\underbrace{\frac{dn(M,z)}{d\ln M}}_{\text{mass function}},$$



Frieman et al. 2008

$$D''(a)+\left[\frac{3}{a}+\frac{H'(a)}{H(a)}\right]D'(a)-\frac{3}{2}\Omega_m(a)\frac{H_0^2}{H^2(a)}\frac{D(a)}{a^5}=0.$$

$$\Omega_{\Lambda(mod)}(z)=\Omega_\Lambda\,(1+z)^{3(1+\omega_0+\omega_a)}\exp\left(-3\omega_a\frac{z}{z+1}\right)$$

$$\rho_i(z)=\rho_{i,0}\exp\left(3\int_0^z\frac{dz}{z+1}[1+w(z)]\right)$$

Experiences:

CMB $C\ell$s : 2015 Planck mission EE ET EE z ≈ 1090

X-ray Clusters : Temp. Sample from BAX z ≈ 0.05

SZ Clusters : Planck 2015 Sample z ≈ 0 -> z ≈ 1

BAO : Boss 2014 z ≈ 0.1,0.15,0.32,0.57,2.36

SNe : JLA z ≈ 0 -> z ≈ 1

Obtained using……

Codes :

CLASS + CAMB _GI : Boltz. Code CMB and P_K generator

SIB_GI : Temp. funct. Module

SZ_count_GI: SZ. count. Module

Montepython + Cosmomc _GI : parameter inference

Likelihoods :

CMB : Planck_lowl and

Planck_highl_TTTEEE

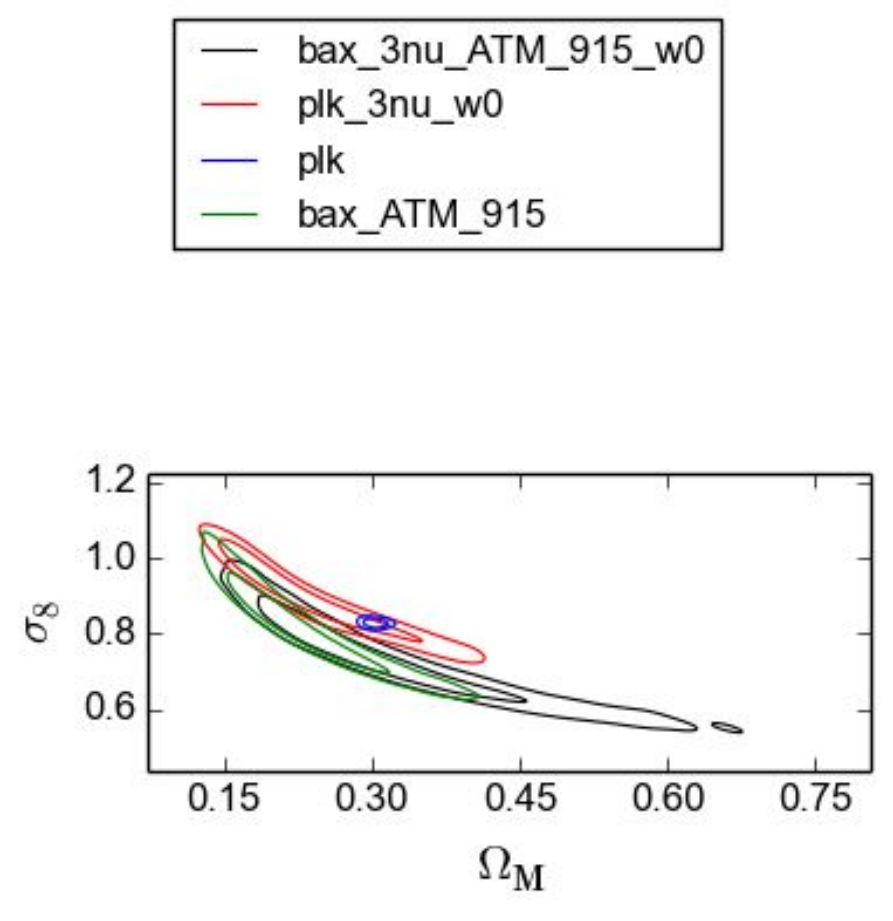
SZ : Poisson

X – ray : Weinbull

BAO SN : Gaussian

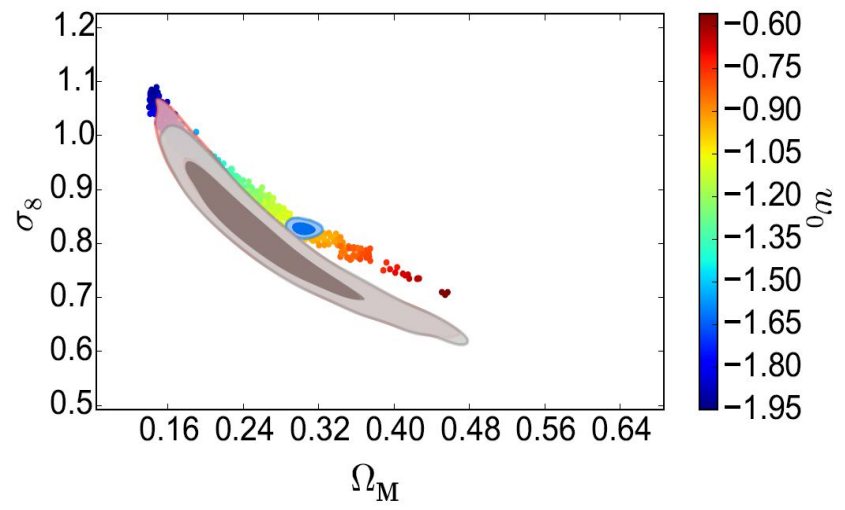
Dark Energy parameter w ≠ -1 ....?

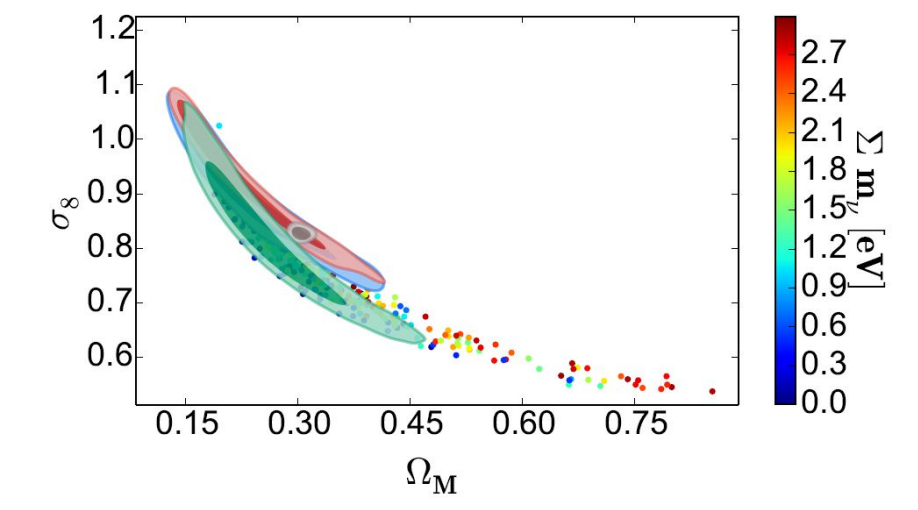
Confront CMB Cls…
with
X – ray sample….



Dark Energy parameter w ≠ -1 ….?

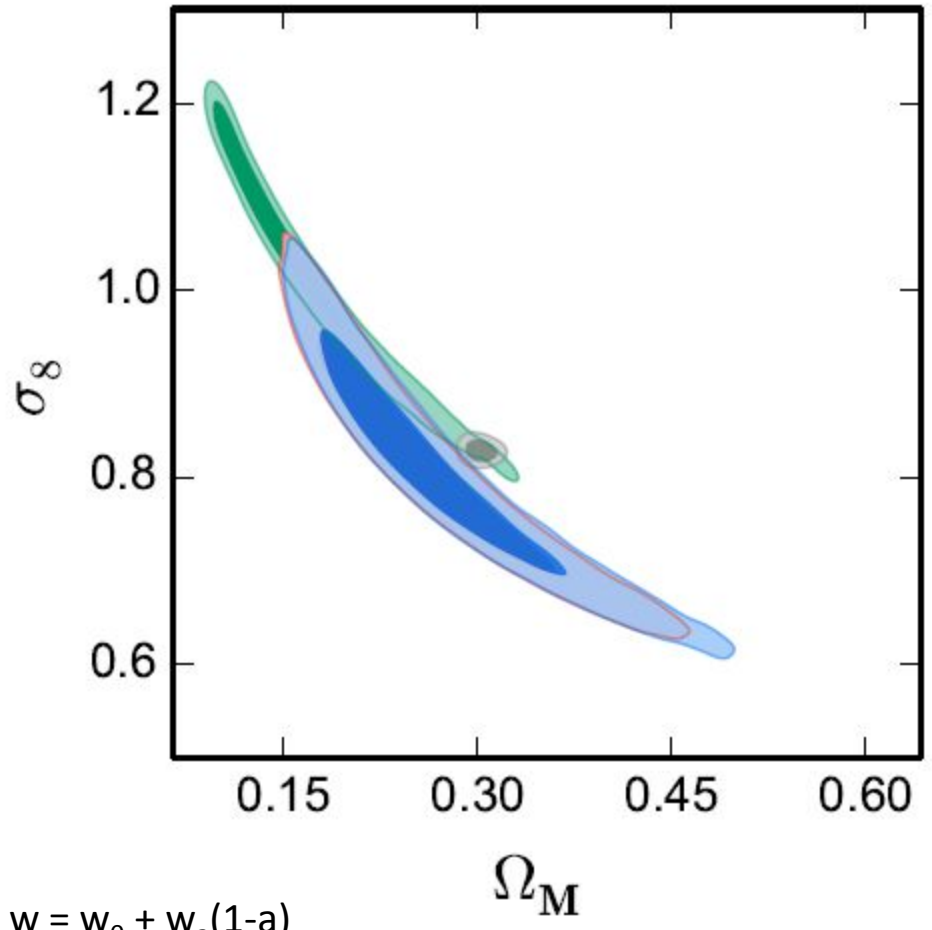
Confront CMB Cls… with X – ray sample….



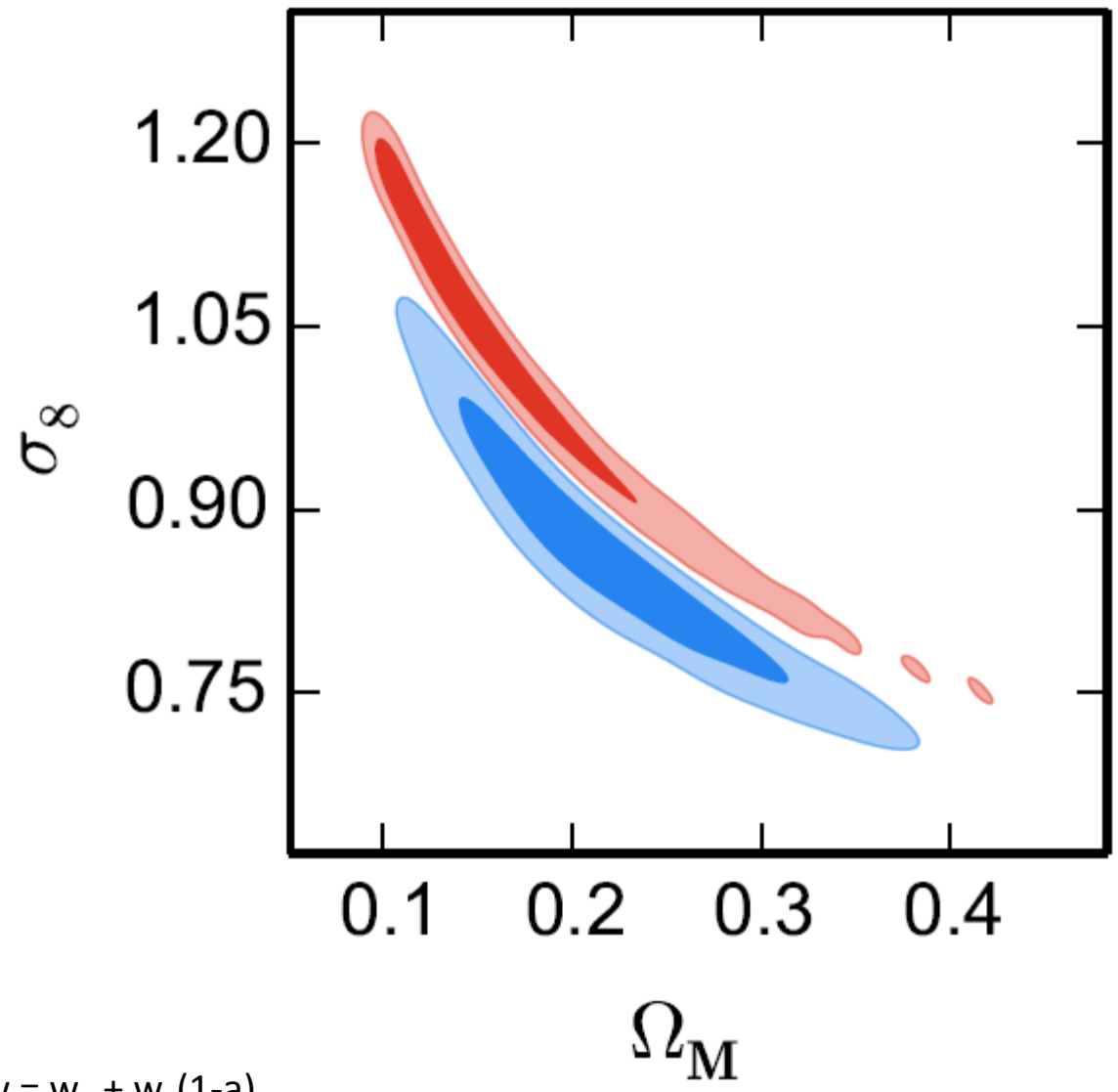


Dark Energy parameter $w = w_0 + w_a(1-a)$*?*

Confront CMB Cls… with X – ray sample….



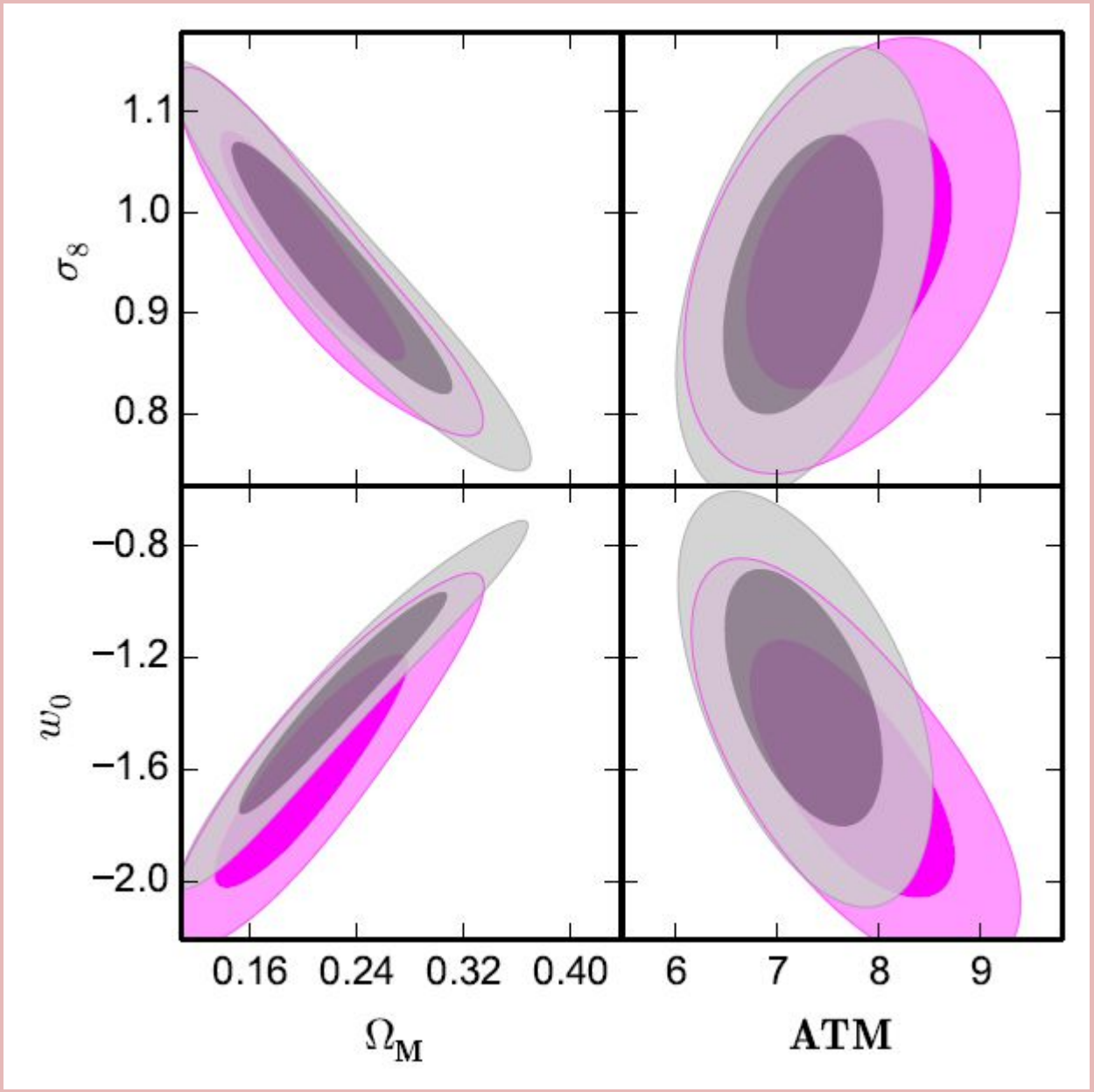
$w = w_0 + w_a(1-a)$



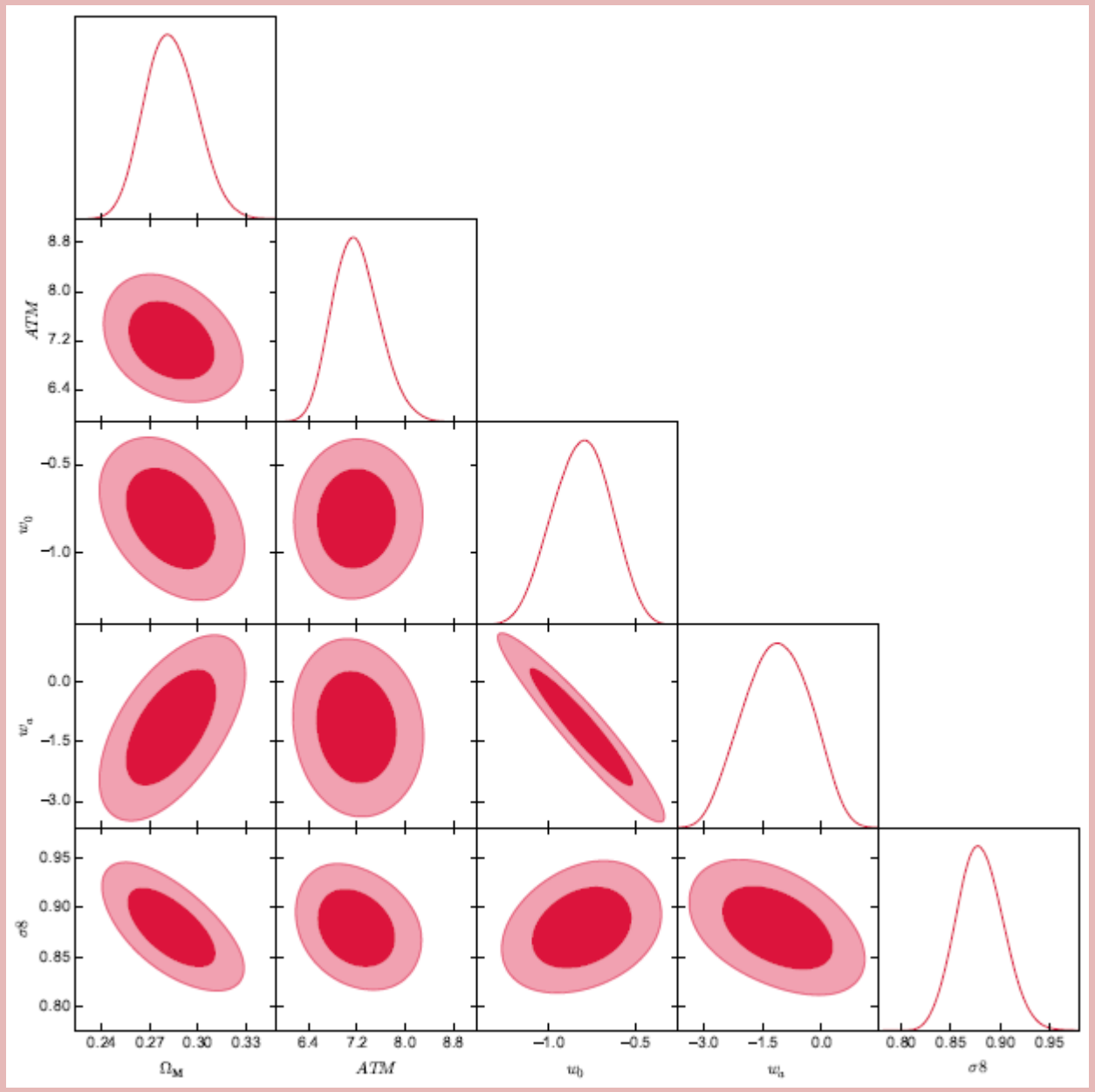
$w = w_0 + w_a(1-a)$

Dark Energy parameter $w \neq -1$ ....?

Confront CMB Cls… with SZ sample….



Combine CMB Cls…
&
X-ray sample….



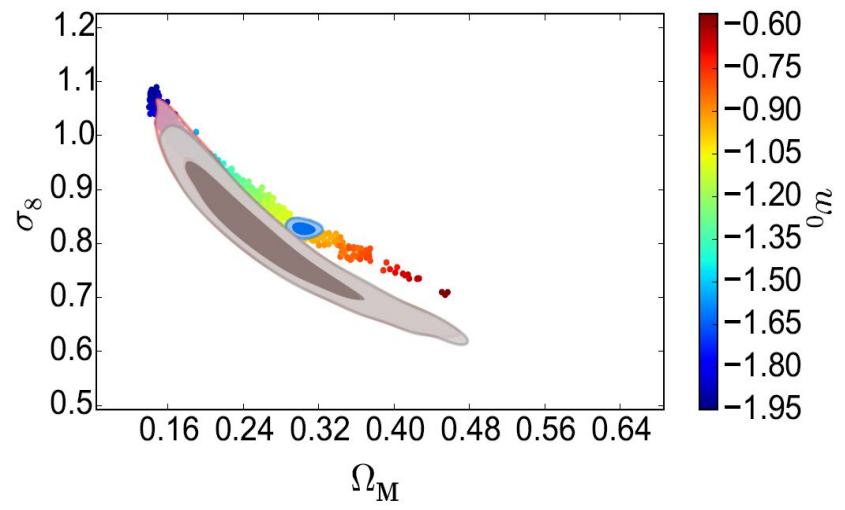
Combine CMB Cls…
&
SZ sample….

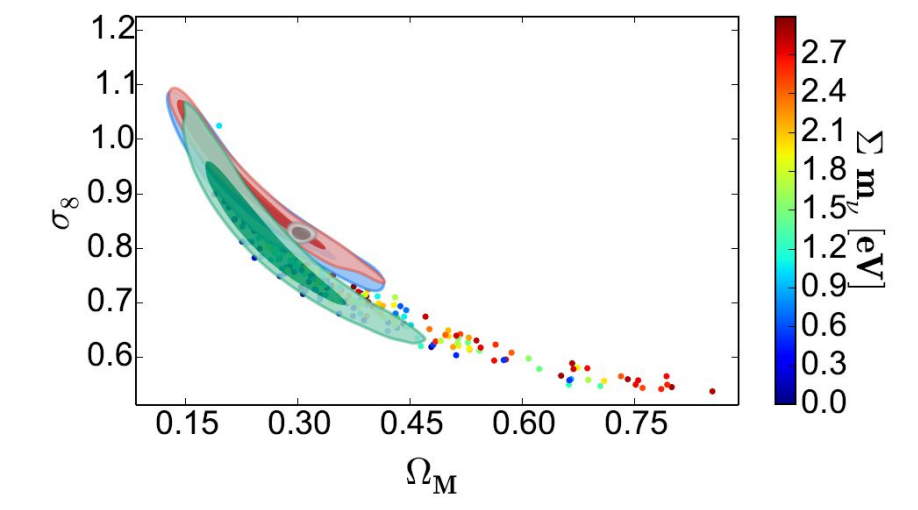
\+
SNa
\+
BAO

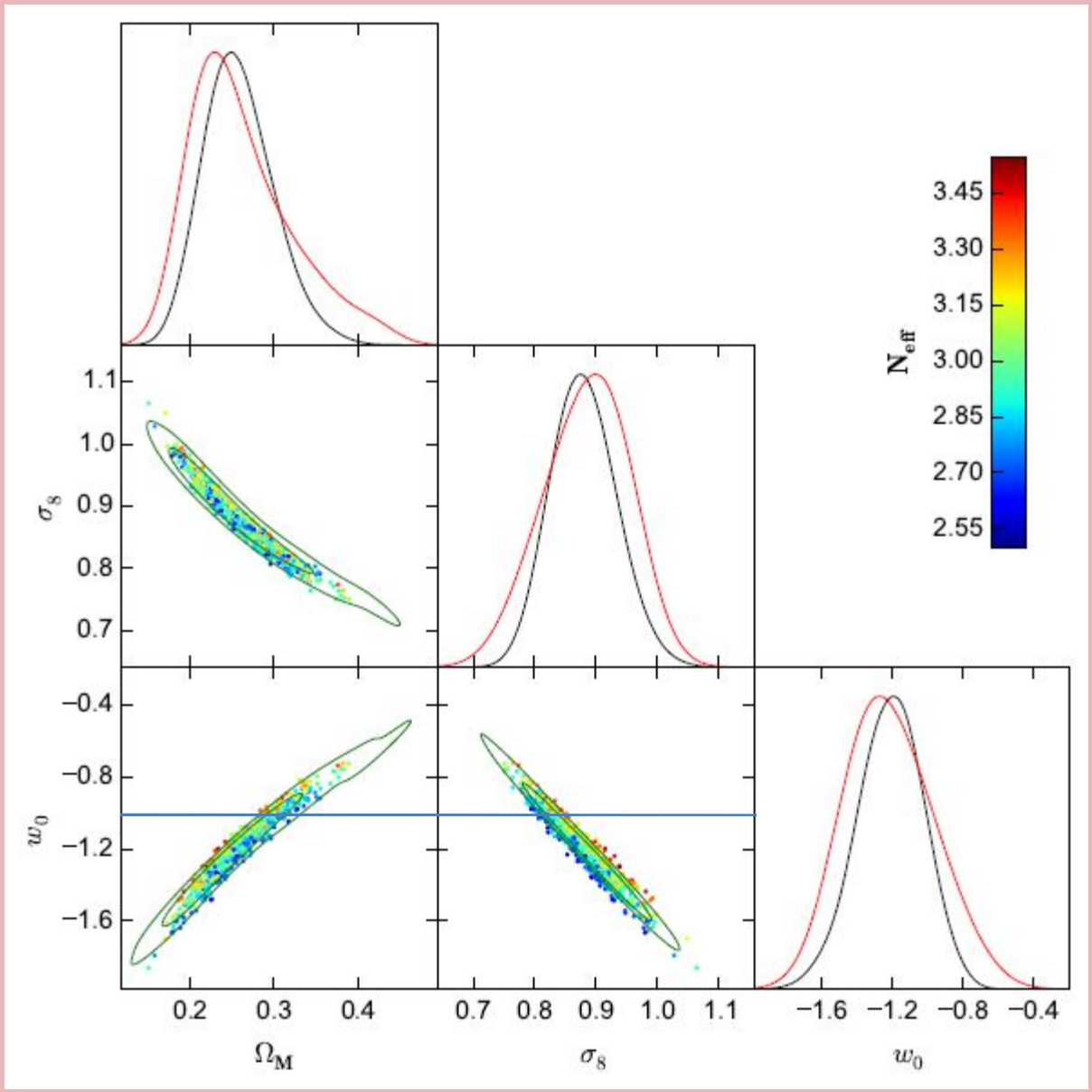
$w = w_0 + w_a(1-a)$

Dark Energy parameter w ≠ -1 ….?

Confront CMB Cls… with X – ray sample….



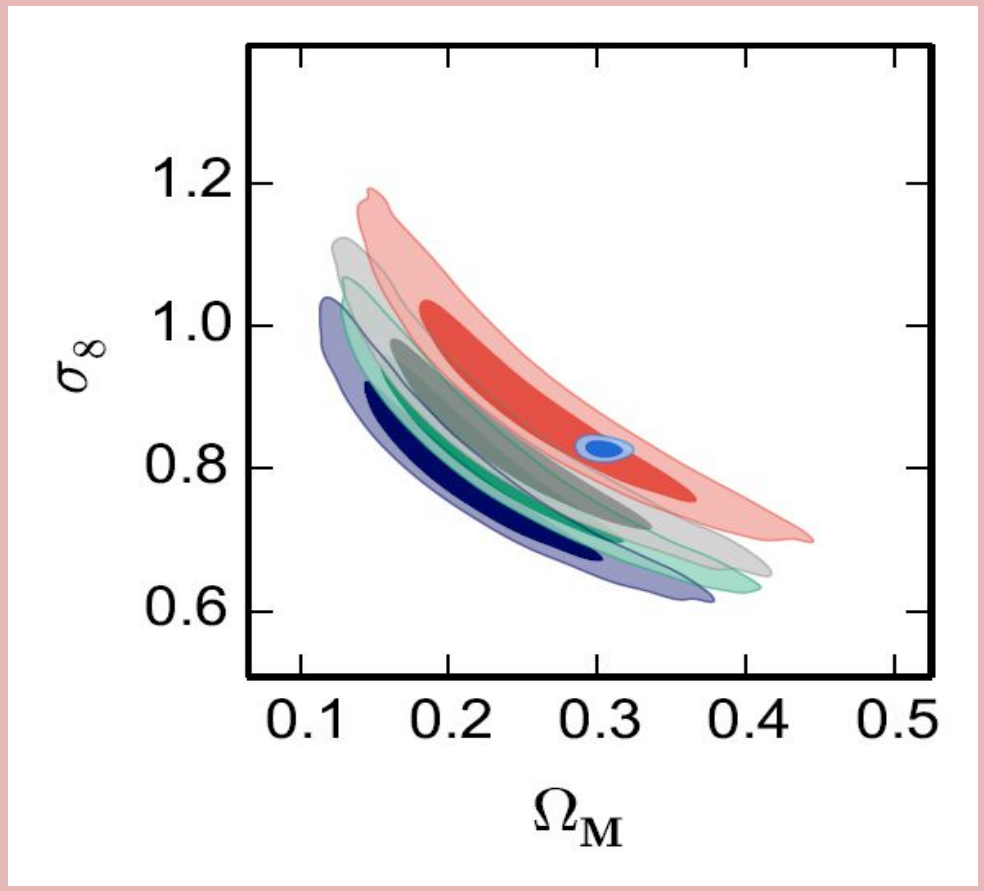




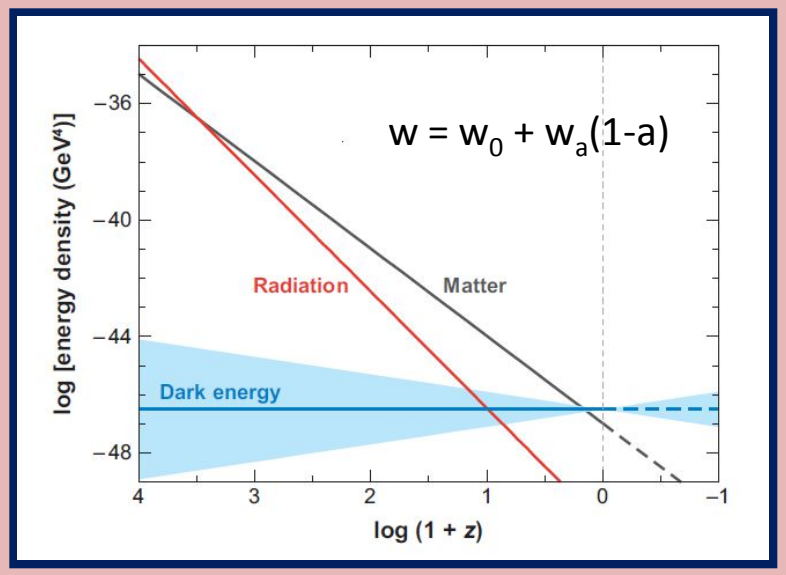
Exotic Neutrino Species
VS
Dark Energy

- Allowing effective number of neutrinos to vary along with a free w has no effect on the σ_8 – Ω_m degeneracy

The main thing….

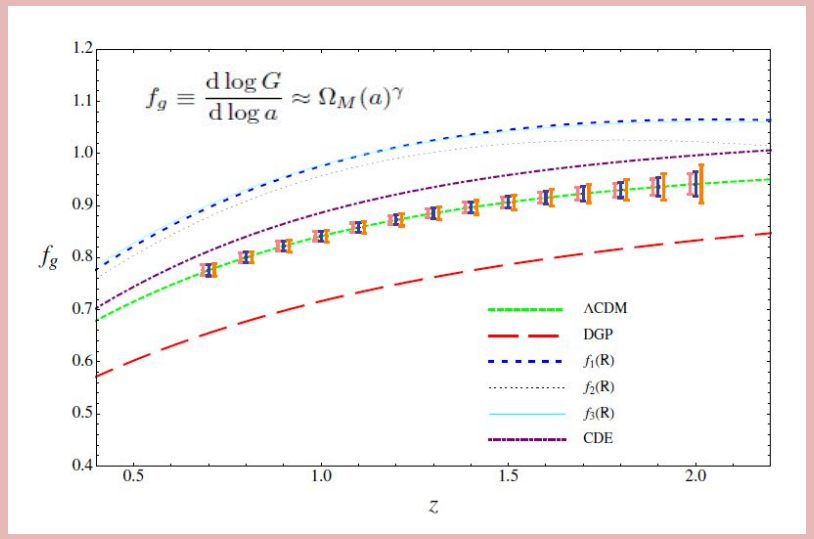


A mis-calibration could be the origin behind the discrepancy



Frieman et al. 2008

1



Euclid TWG review 2013

2

1

$$\rho_i(z) = \rho_{i,0} \exp\left(3 \int_0^z \frac{dz}{z+1}[1 + w(z)]\right)$$

2

$$f' + f^2 + \left(1 + \nu + \frac{H'}{H}\right) f - \frac{3}{2}\mu\,\Omega_{\mathrm{m}} = 0$$

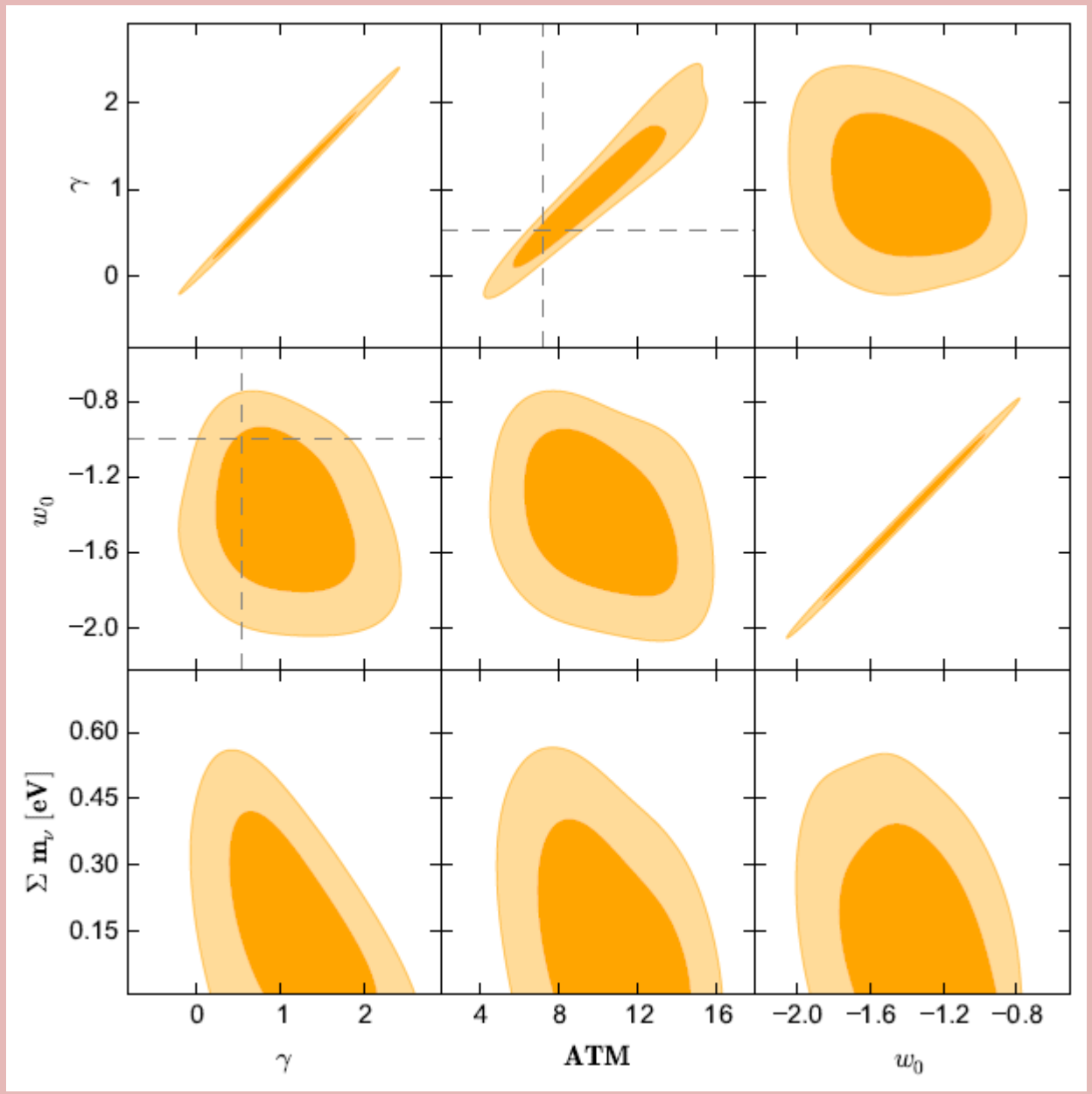
$f(z) = \Omega_m{}^{\gamma}(z)$

Mixing Dark Energy & Modified Gravity

Case 1 : γ + ω

Case 2 : $\gamma = \frac{3(1-w)}{5-6w}.$ + $\Delta\gamma$ Wang 1998

$$\sigma_{\gamma,wCDM}(z) = \frac{D_{\Lambda CDM}(z_*)}{D_{\gamma,CDM}(z_*)} \frac{D_{\gamma,CDM}(z)}{D_{\Lambda CDM}(z)} \sigma_{wCDM}(z)$$



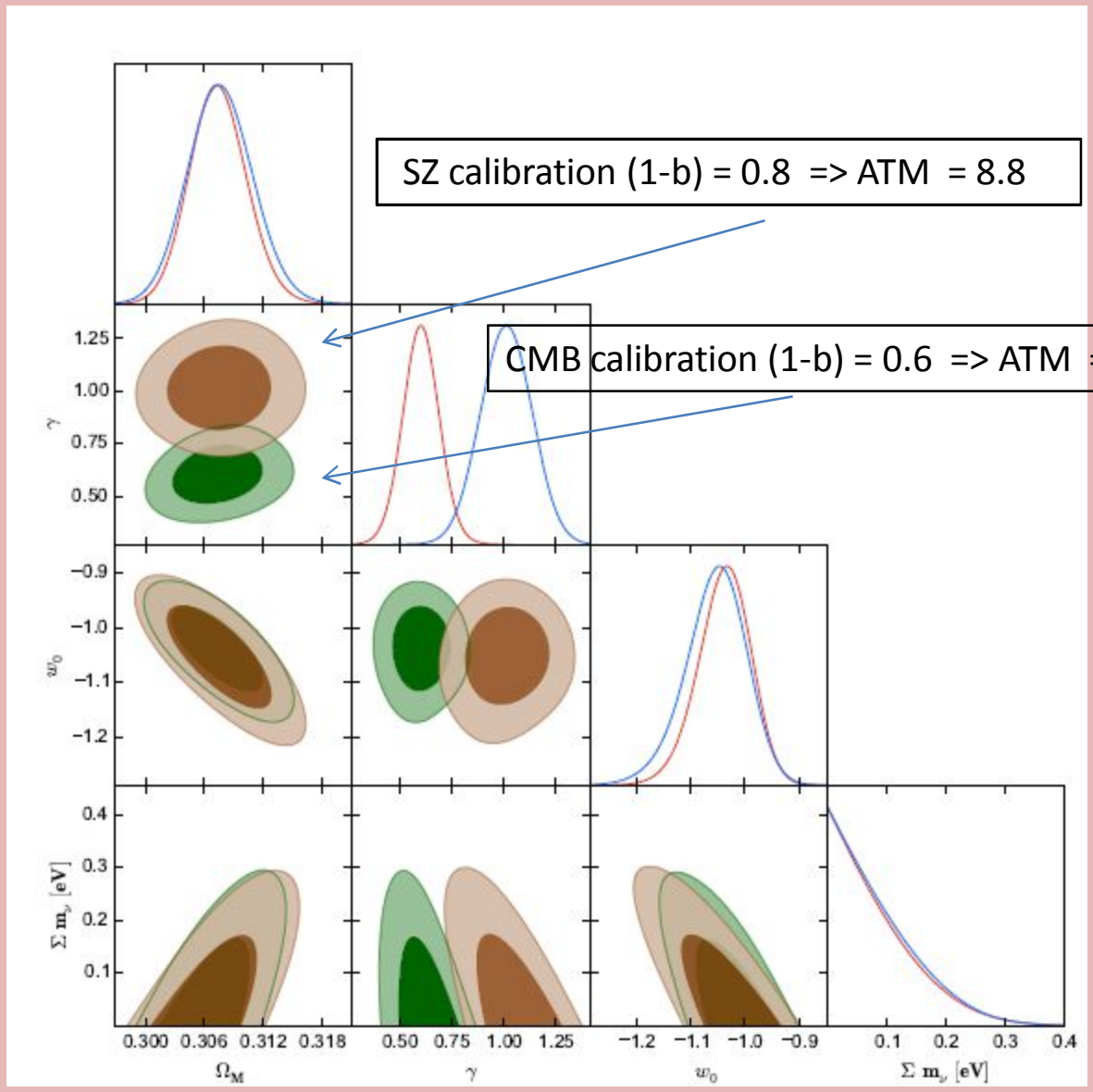
Combine CMB Cls…
&
X-ray sample….

Case 1 :

γ

✚

w ≠ -1



Case 1 :

γ

✚

w ≠ -1

…combining all…

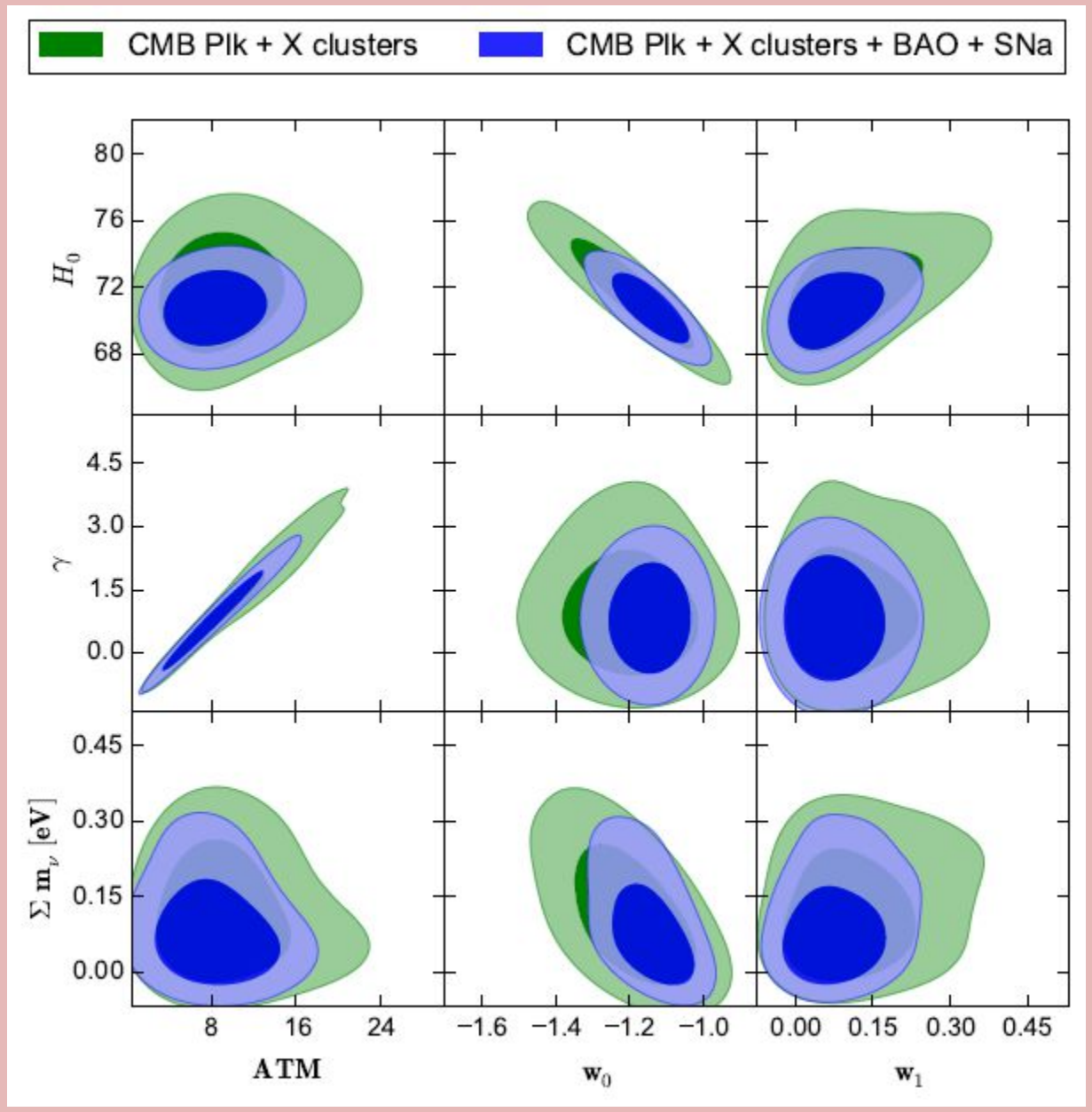
X –ray
+
CMB
+
SNa
+
BAO

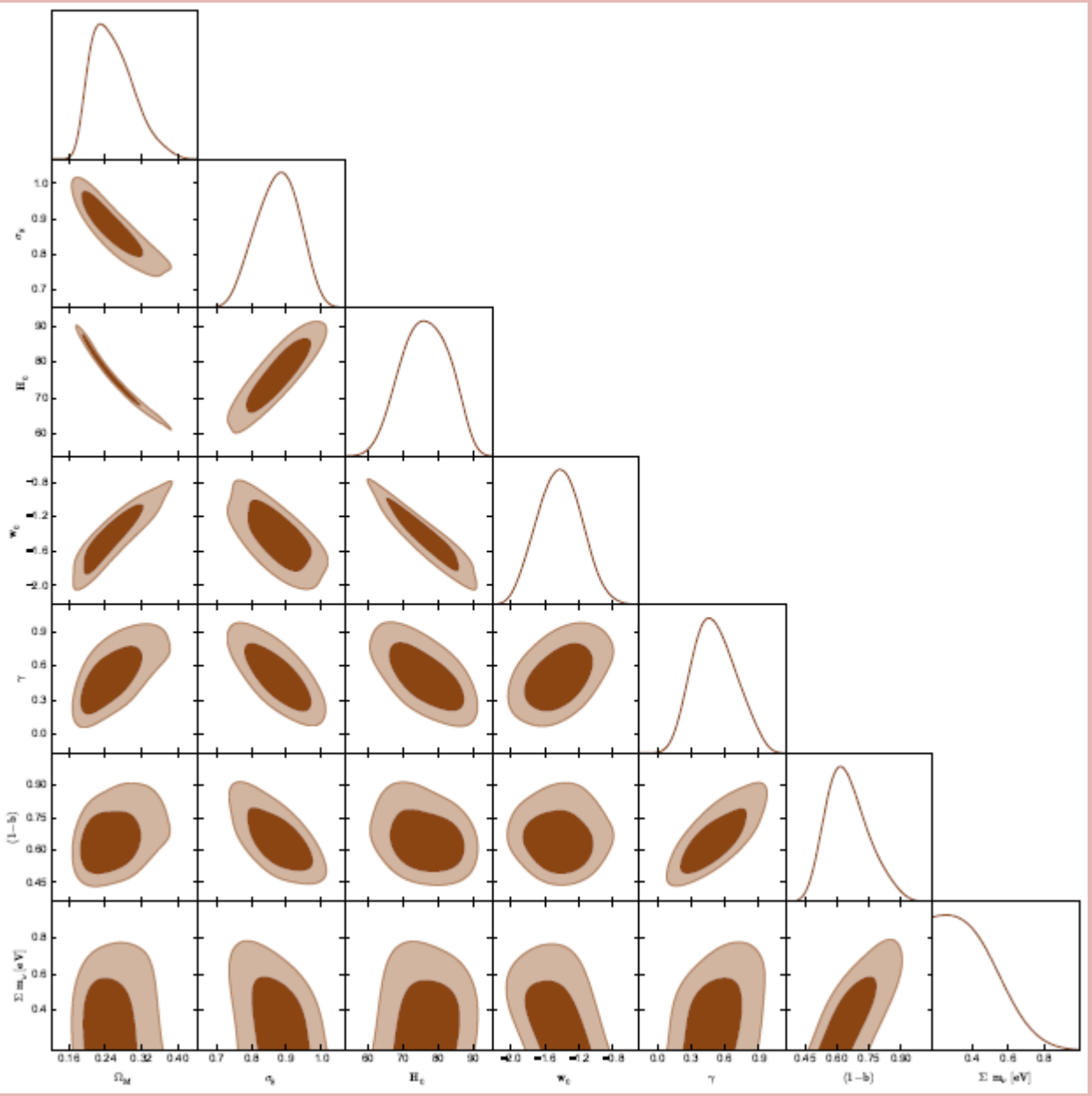
-No effect from a dynamical ω on the γ - ATM correlation when X ray and CMB are combined
- Adding additional probes constrain more ω from altering the former correlation

Case 1 :

γ ✚

$w = w_0 + w_a(1-a)$





Combine CMB Cls…
&
SZ sample….

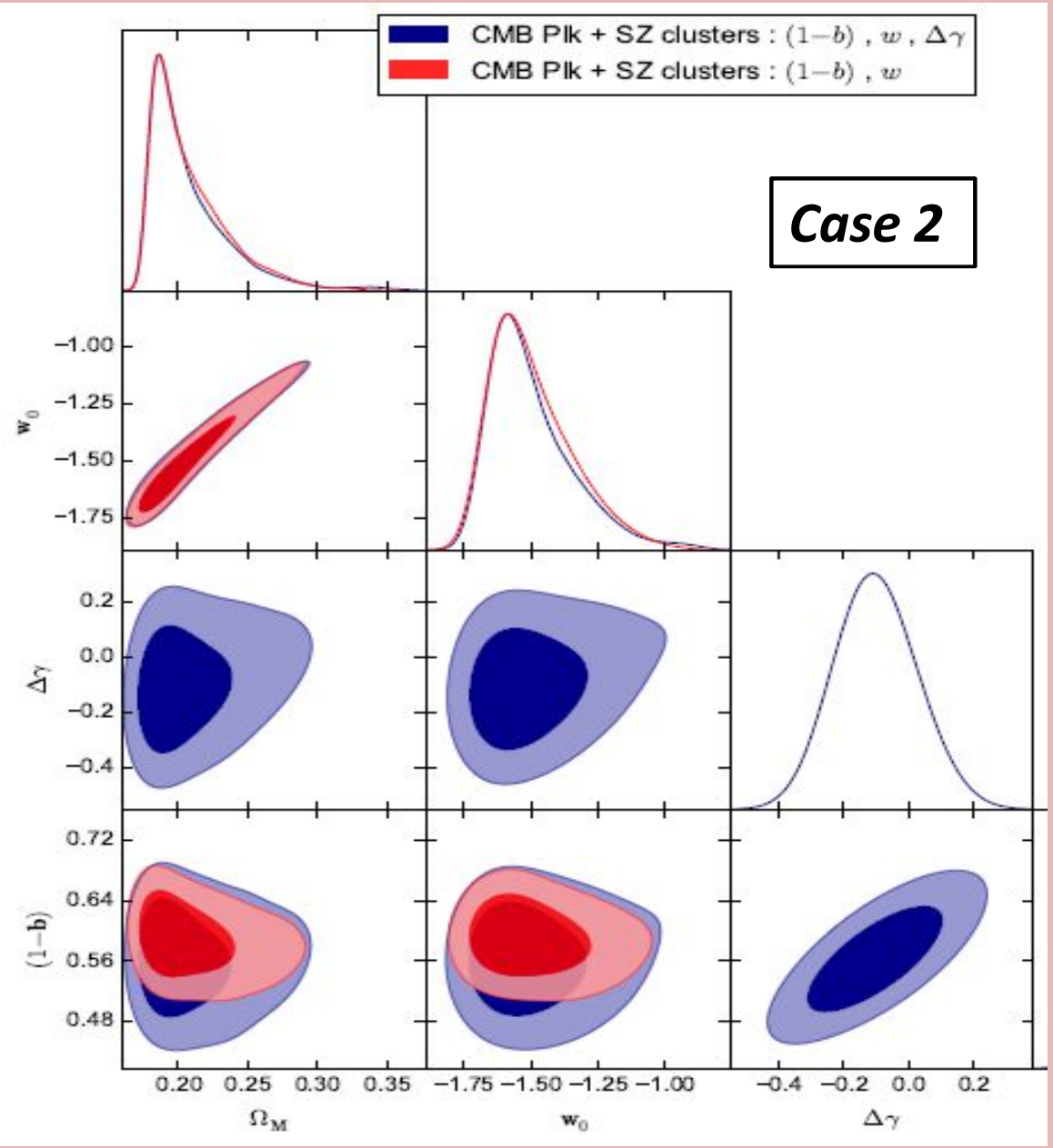
\+ SNa

Case 1 :

γ

✚

w cte



Combine CMB Cls…
&
SZ sample….

- No correlation between ω and (1-b) while a pure growth index still correlates with (1-b)

Thank you