New neutrino mass bounds from BOSS photometric luminous galaxies

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in collaboration with:

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Introduction

- Neutrino oscillation experiments have adduced robust evidence for a non-zero neutrino mass but they are not sensitive to the absolute scale of neutrino masses.

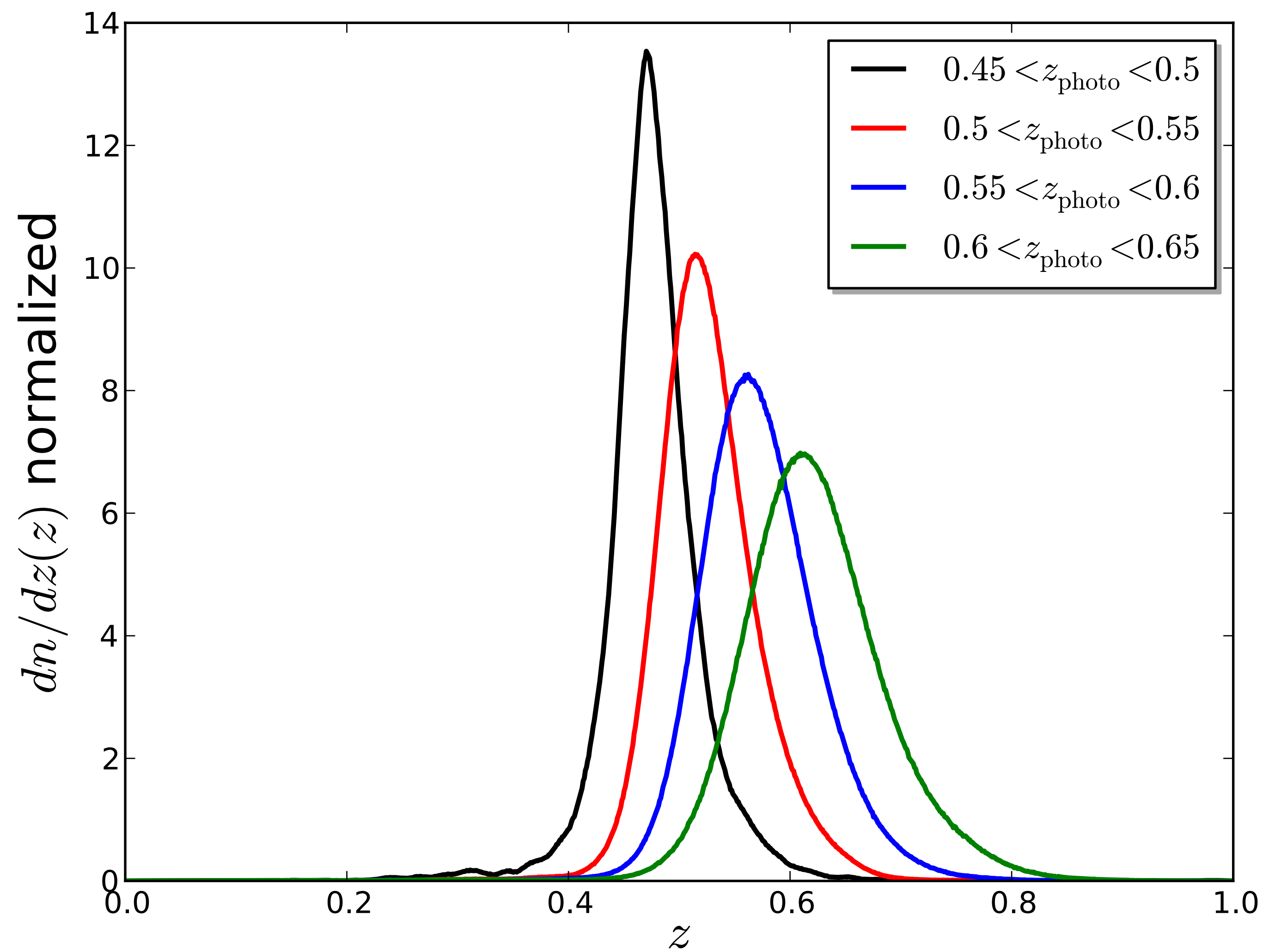
- Cosmology provides one of the means to tackle the absolute scale of neutrino masses. A current limit on the sum of neutrino masses is $\Sigma m_\nu < 0.6\ \mathrm{eV}$ at 95% CL, depending on the cosmological data and on the cosmological model.

- We derive neutrino mass constrains from the angular power spectra of galaxy density at different redshifts, in combination with priors from the CMB and from measurements of the Hubble parameter.

Data

- Imaging data from DR8 (Aihara et al, APJS '11) of Sloan Digital Sky Survey III, SDSS-III (York et al, APJ '00)

- The first data release of the Baryon Oscillation Spectroscopic Survey, BOSS (Eisenstein et al, APJ '11)



Ross et al, APJ '11

CMASS sample of luminous galaxies (White et al APJ '11) is divided into four photometric redshift bins,

$$z_{\rm photo} = 0.45 - 0.5 - 0.55 - 0.6 - 0.65$$

It covers an area of 10,000 square degree and consists of 900,000 galaxies.

Angular power spectra of the galaxy density

The theoretical power spectra is given by:

$$C_\ell^{(ii)} = b_i^2 \, \frac{2}{\pi} \int k^2 dk \, P_m(k, z=0) \left(\Delta_\ell^{(i)}(k) + \Delta_\ell^{\mathrm{RSD},(i)}(k) \right)^2$$

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four free bias, one
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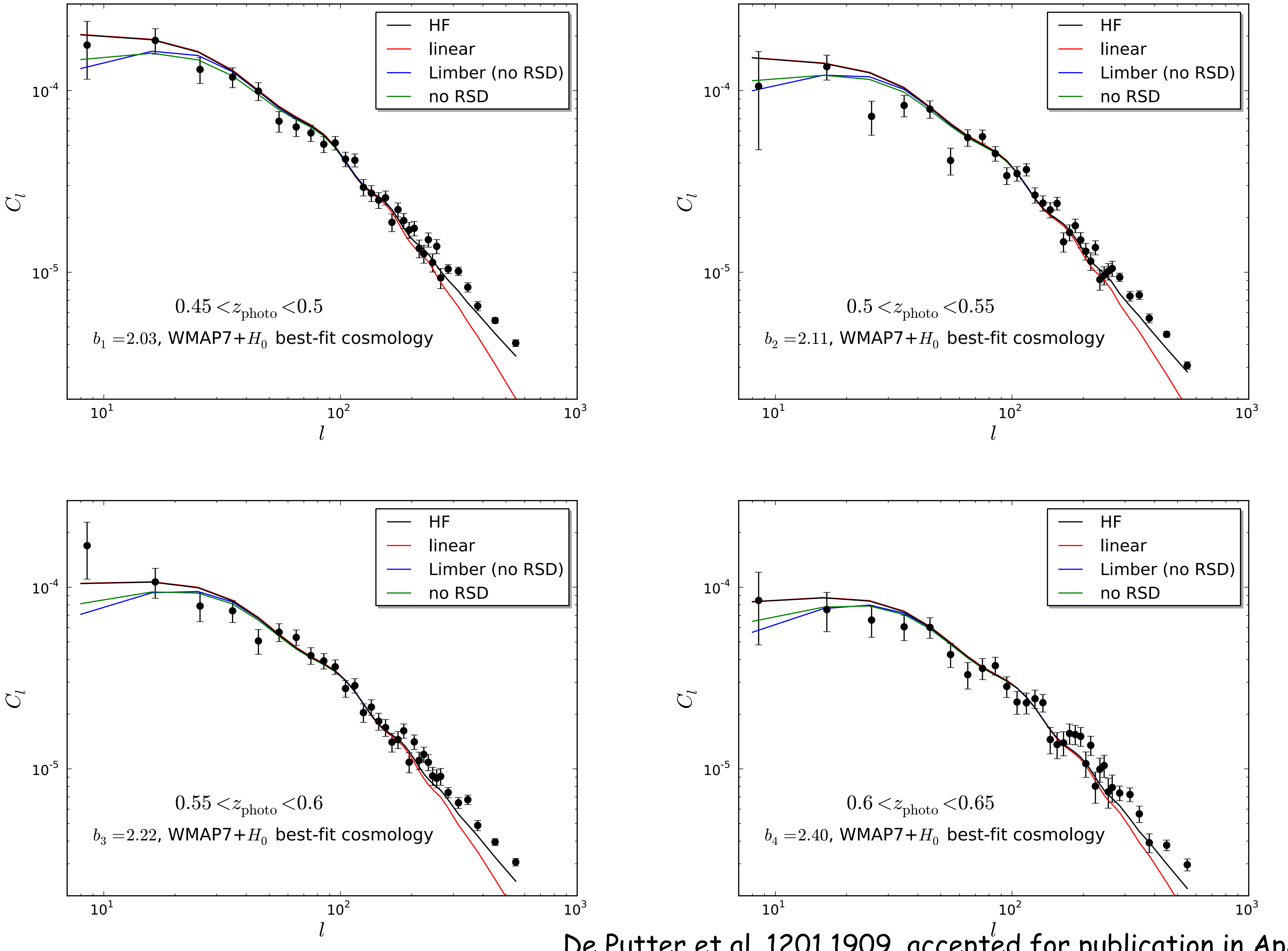
Multipole range

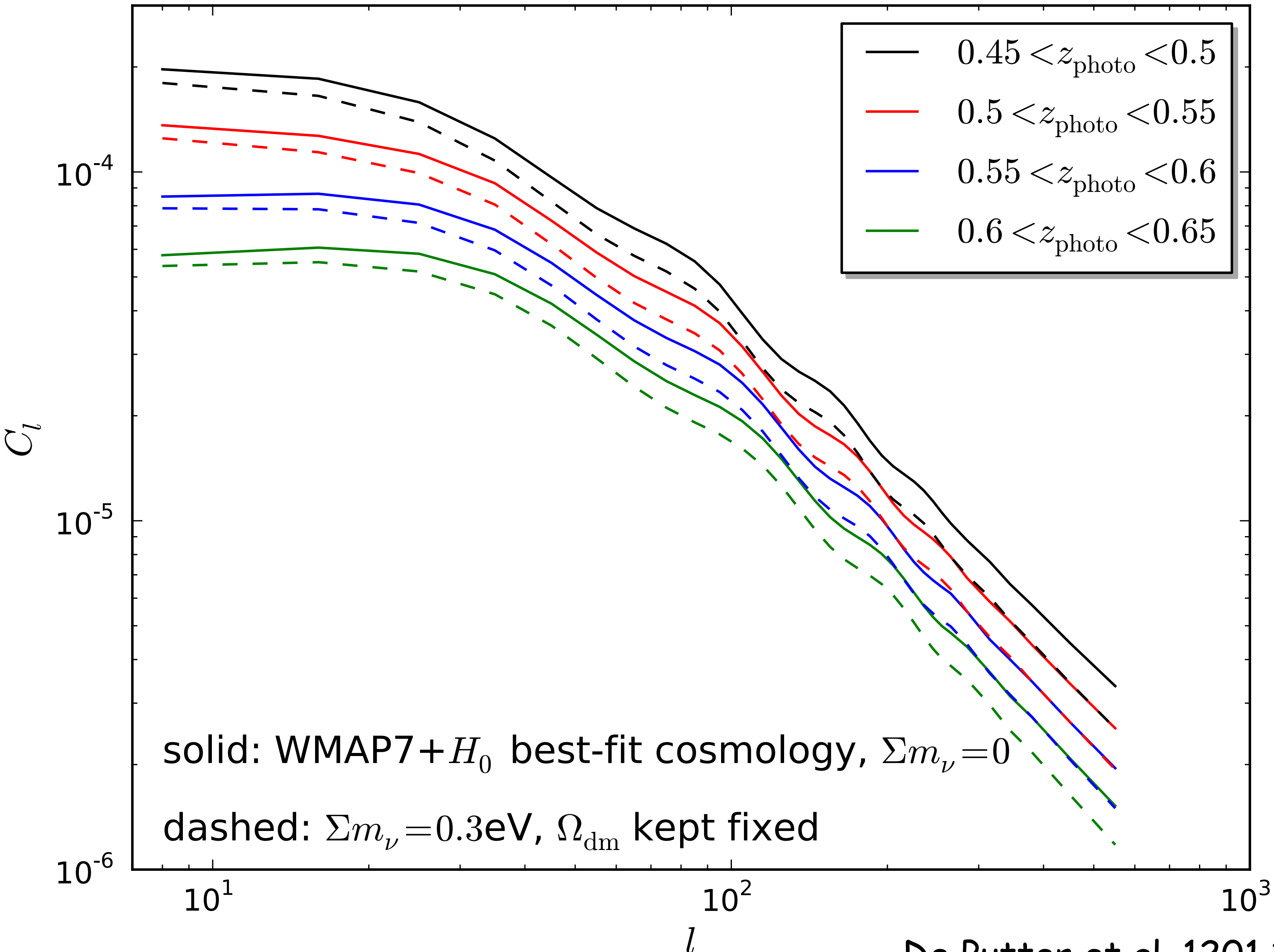
$30 < \ell < 150$ and $30 < \ell < 200$

Angular power spectra of the galaxy density



De Putter et al. 1201.1909, accepted for publication in ApJ

Effect of massive neutrinos on the angular power spectra



We assume that there are three degenerate species of massive neutrinos with

$$\Sigma m_\nu = 0.3\text{eV}$$

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In the presence of massive neutrinos the angular power spectra are suppressed at any redshift. This suppression could be partially compensate by increasing the cold dark matter energy density, while the effect of bias is to lower the power spectra at any multipole range.

MCMC Analysis and Results

ΛCDM + neutrino mass fraction f_ν, Amplitude of the Sunyaev-Zel'dovich spectrum A_{SZ}, four galaxy bias parameters b_i and (optionally) four nuisance parameters a_i

$$\{\Omega_b h^2,\ \Omega_c h^2,\ \Theta_s,\ \tau,\ n_s,\ \log[10^{10} A_s],\ f_\nu,\ A_{SZ},\ b_i,\ a_i\}$$

$$\Omega_\nu = \frac{\sum m_\nu}{93.1 h^2 \mathrm{eV}}$$

→ We derive Σm_ν

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95% CL $\sum m_\nu$[eV]	prior only	prior+CMASS,$\ell_{\mathrm{max}} = 150$	prior+CMASS,$\ell_{\mathrm{max}} = 200$
WMAP7 prior	1.1	0.76 (0.95)	0.55 (0.91)

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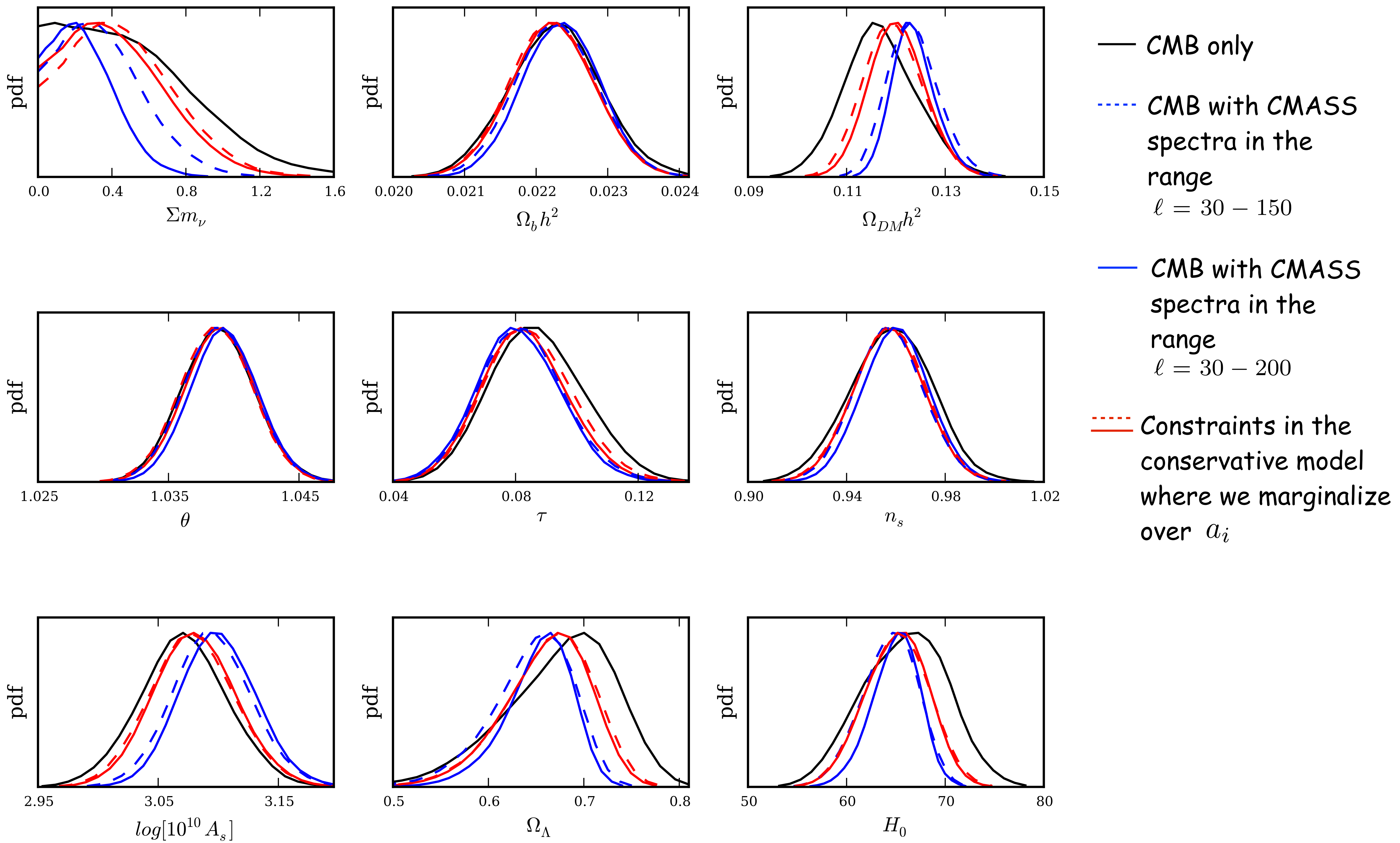
marginalization over the parameters a_i

Posterior probability for all cosmological parameters



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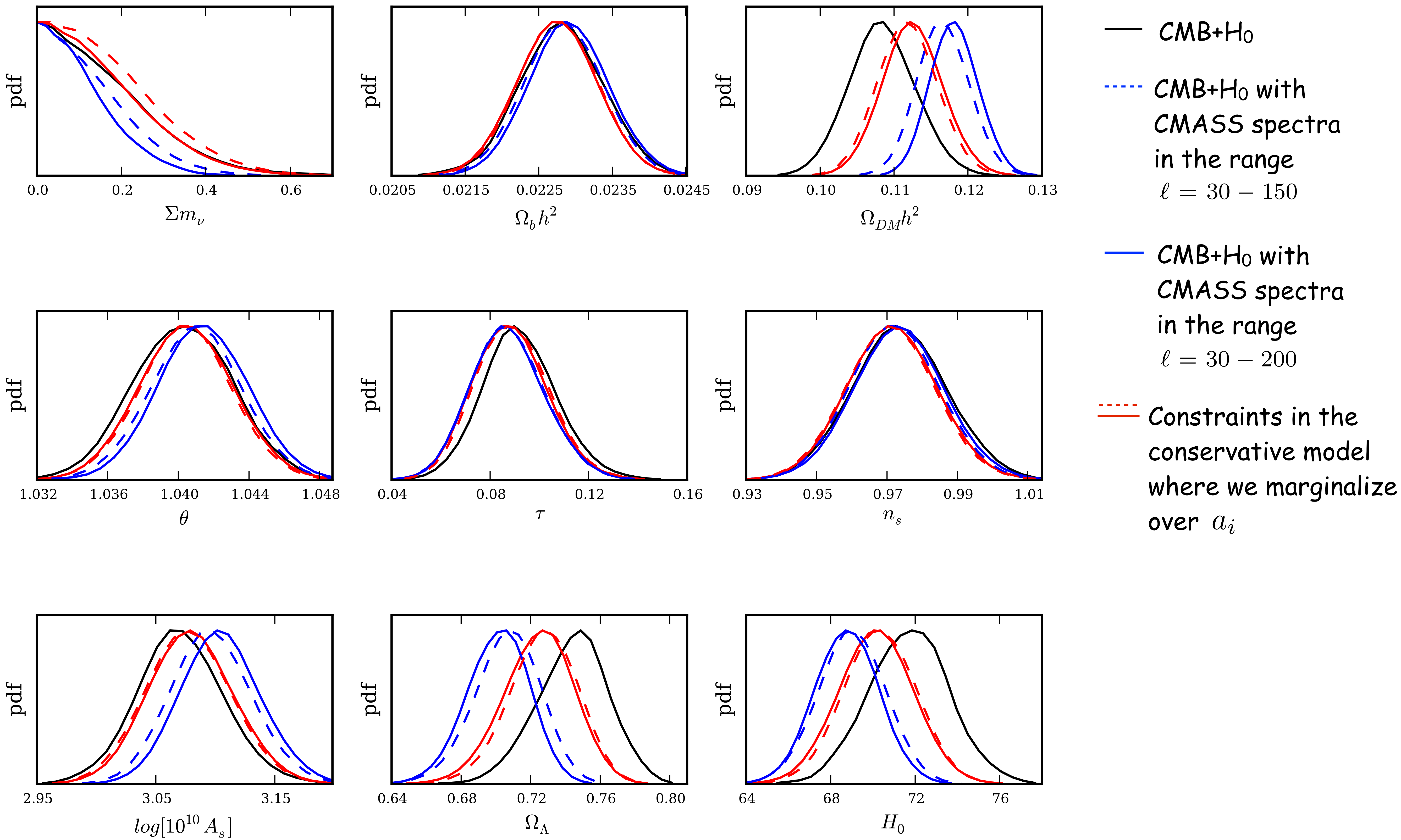

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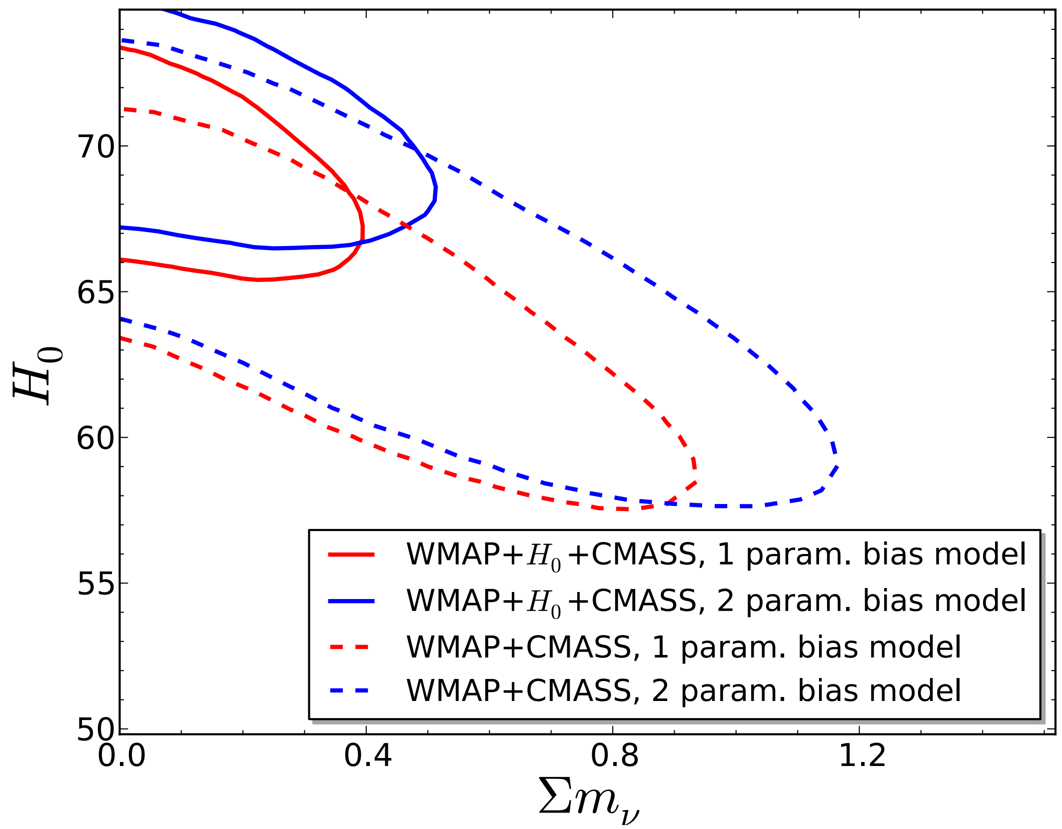
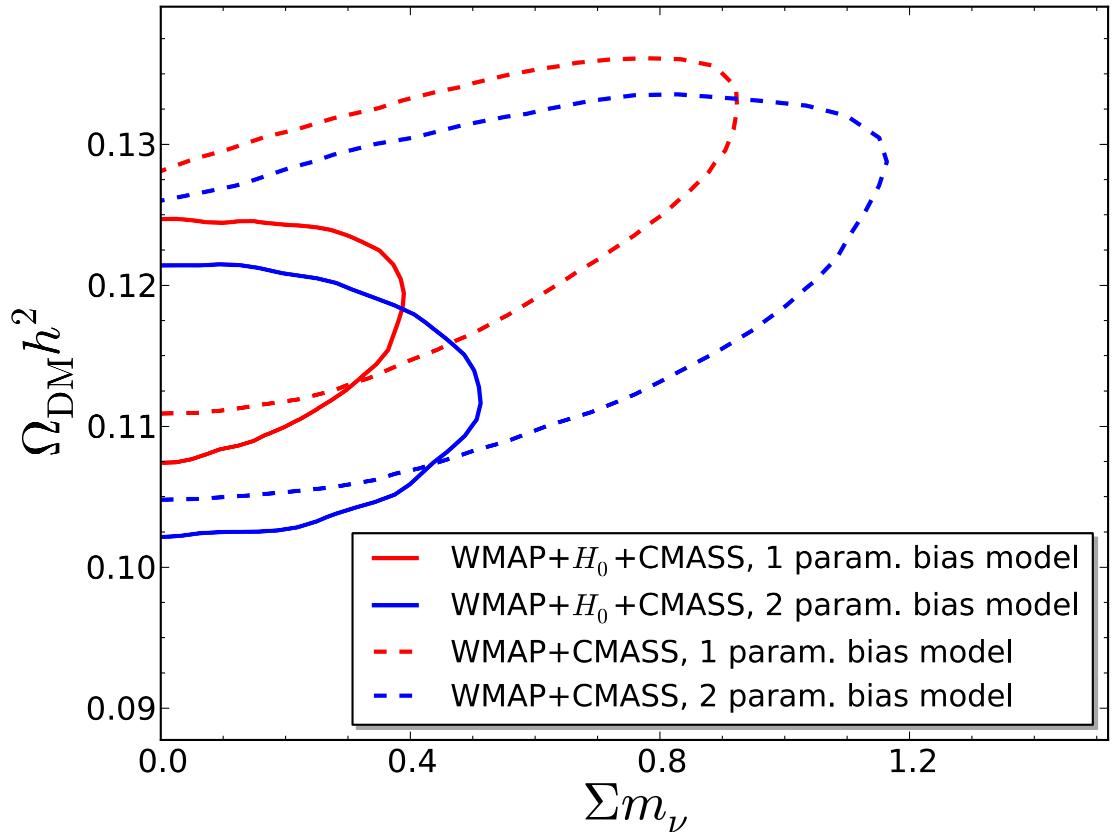
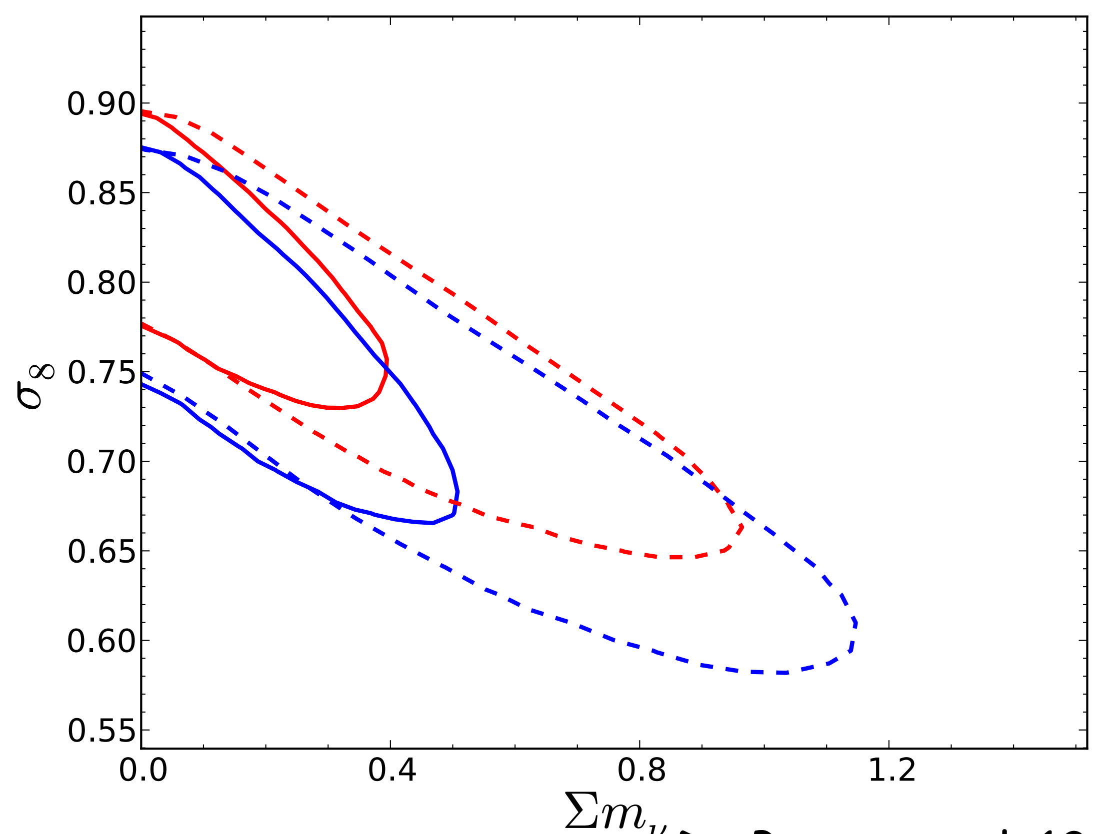
Correlations between parameters







$\ell = 30 - 150$

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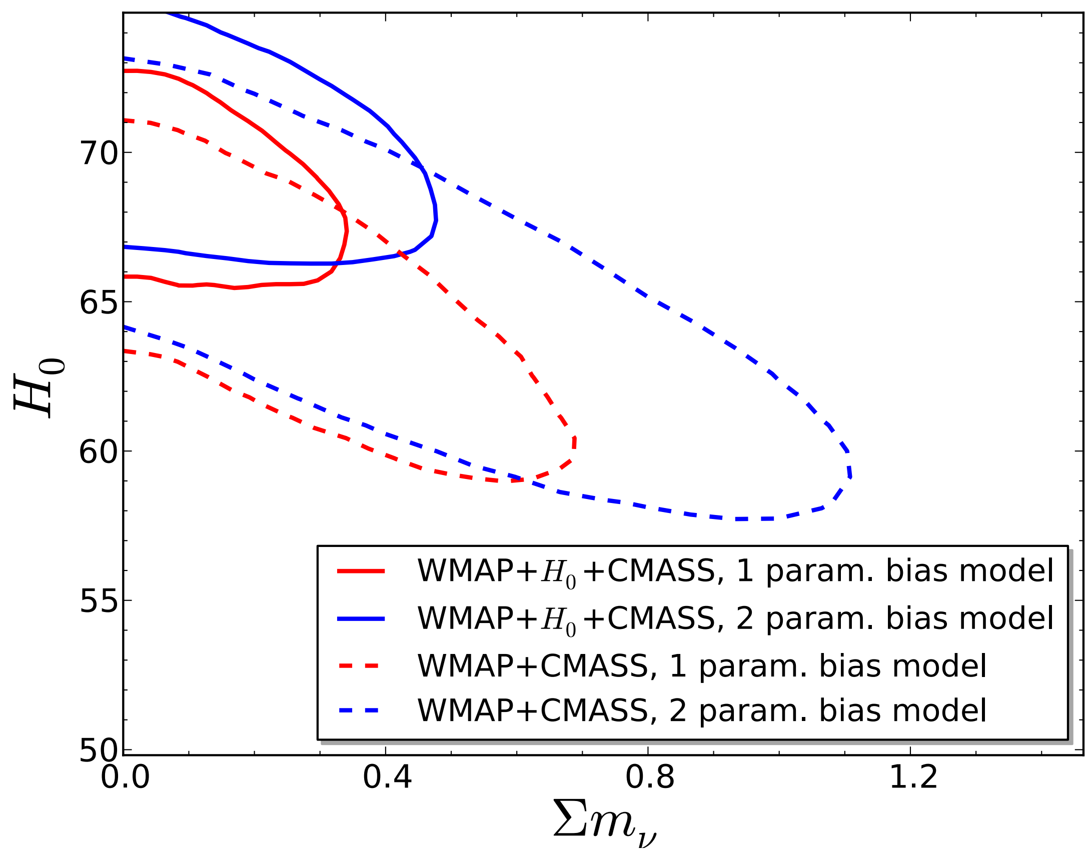

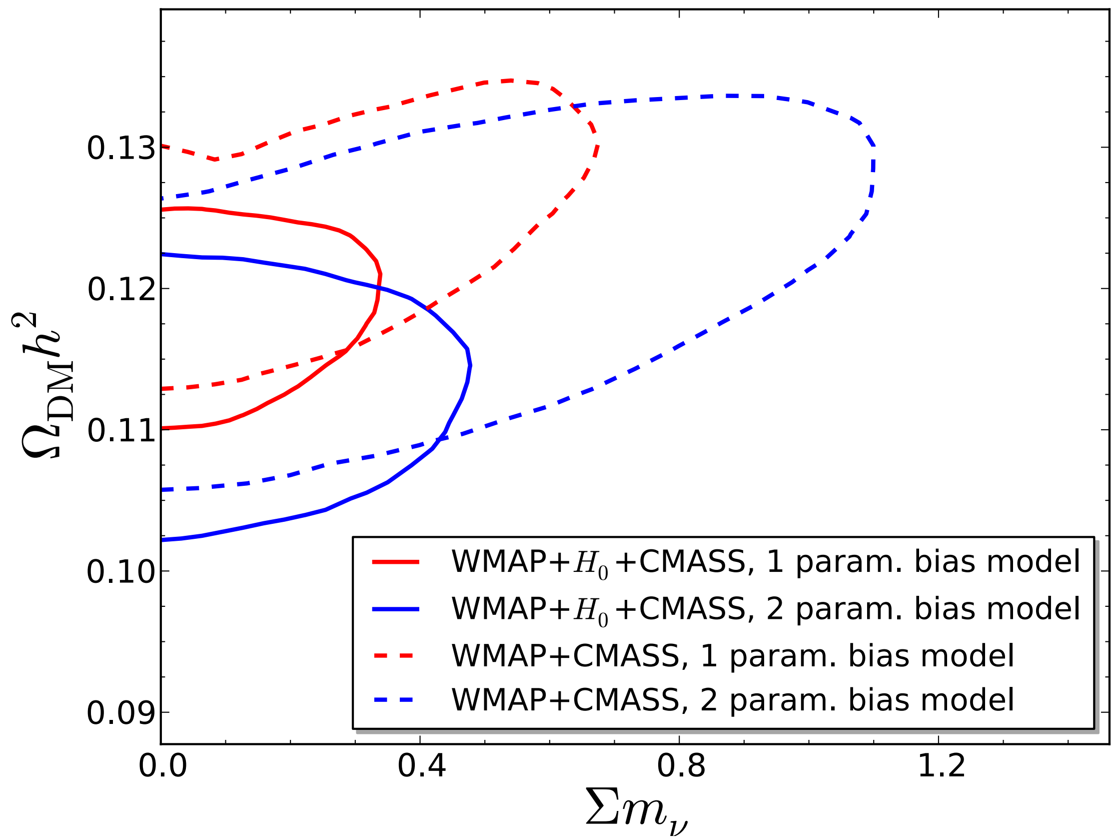

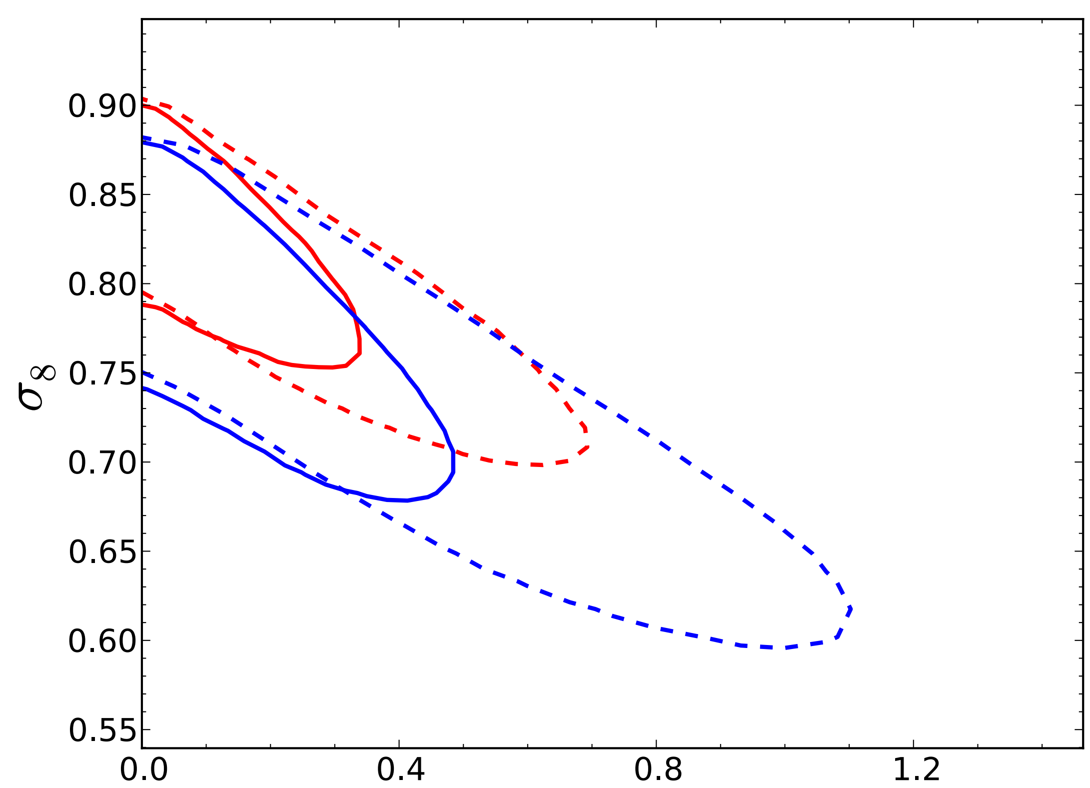

$$\ell = 30 - 200$$

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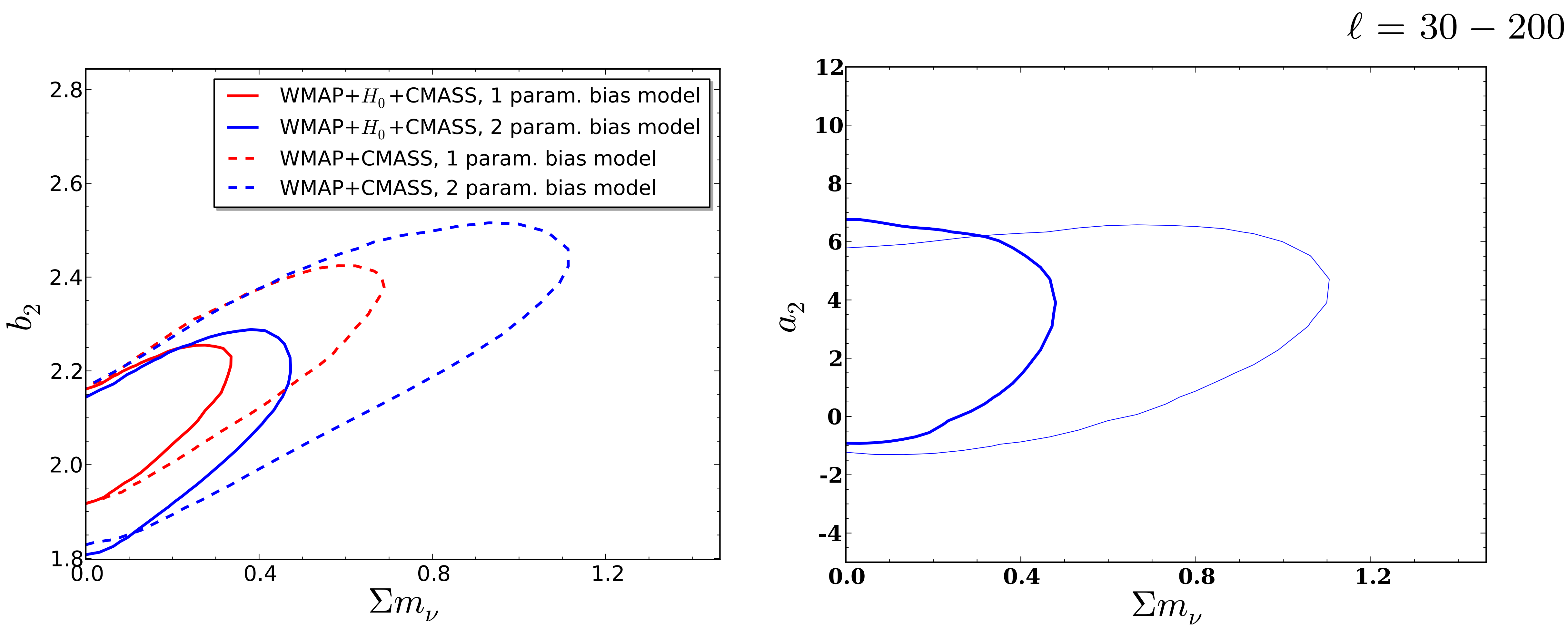
Correlations between parameters



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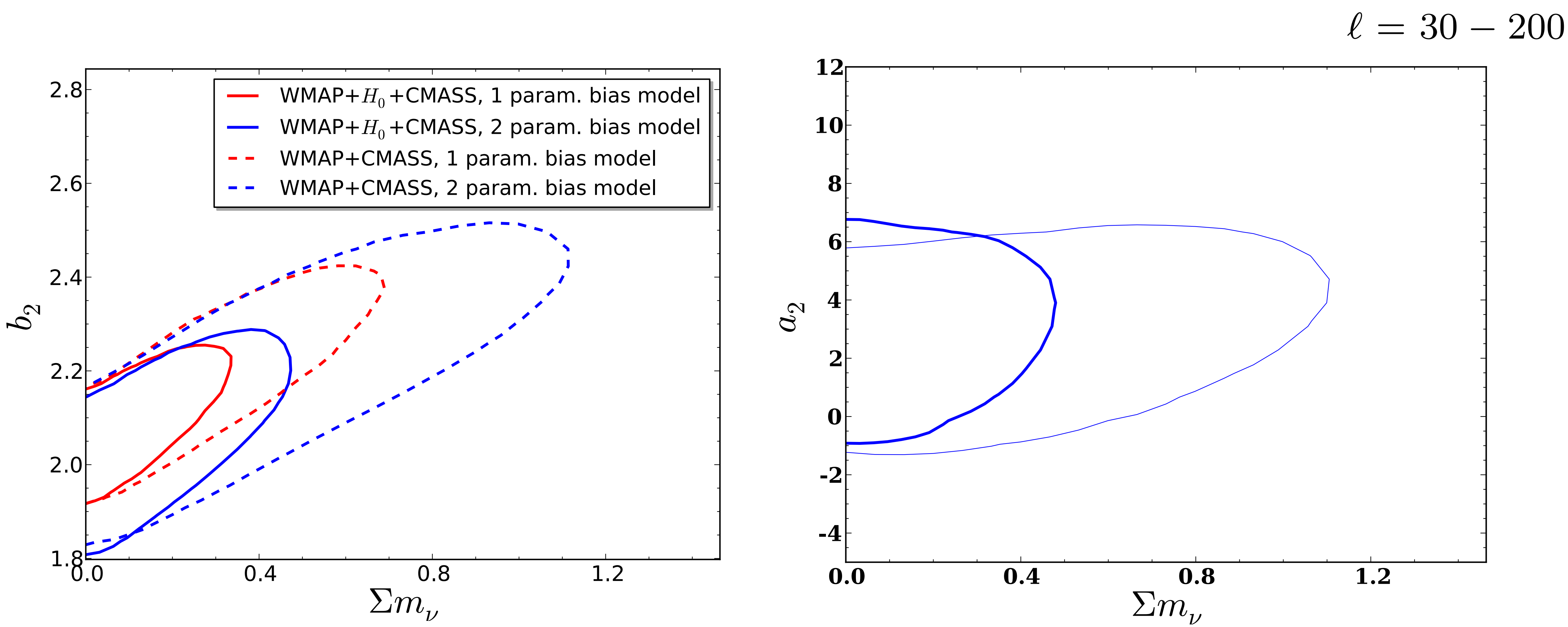

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We also add supernova and BAO data to the CMB+HST+CMASS data sets, and consider the neutrino mass bound with the bias only (i.e. without shot noise). We find a negligible improvement (from 0.27 eV to 0.25 eV) relative to the case without these additional data sets.

Conclusions

- We have exploited angular power spectra from the SDSS-III DR8 sample photometric galaxy sample CMASS to set constraints on the sum of neutrino masses. We have considered a flat ΛCDM scenario plus three active massive neutrino species.
- Combining the CMASS data with CMB data we find an upper bound $\Sigma m_\nu < 0.55$ eV at 95% CL in the model with free bias parameter. Adding HST we find $\Sigma m_\nu < 0.27$ eV at 95% CL.
- Considering a conservative galaxy bias model containing additional shot noise parameters the bounds are weakened, $\Sigma m_\nu < 0.91$ eV at 95% CL for CMB+CMASS and $\Sigma m_\nu < 0.38$ eV at 95% CL for CMB+HST+CMASS.