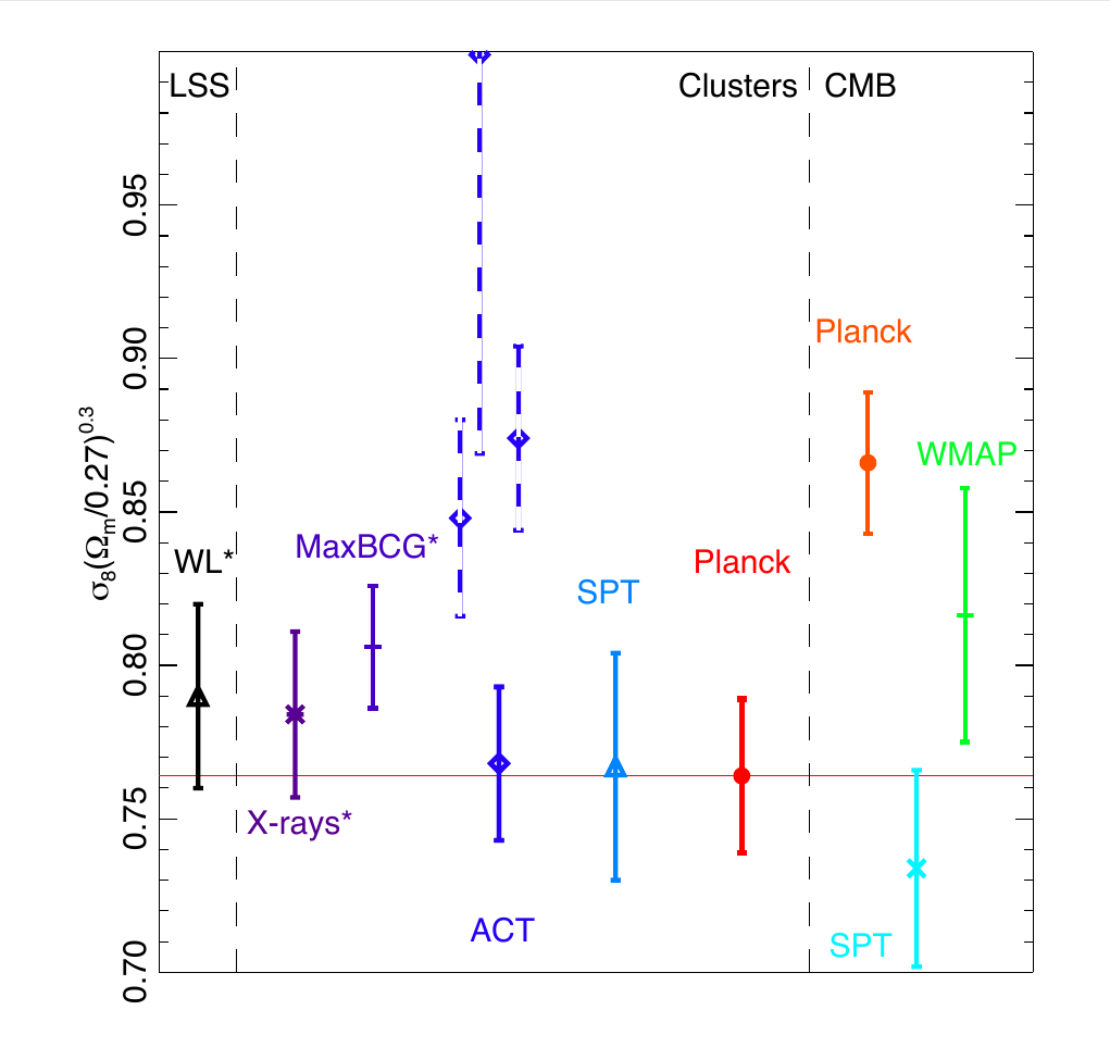
Current cosmological constraints on linear matter density perturbations amplitude, neutrino mass and number of relativistic species

R. Burenin

IKI

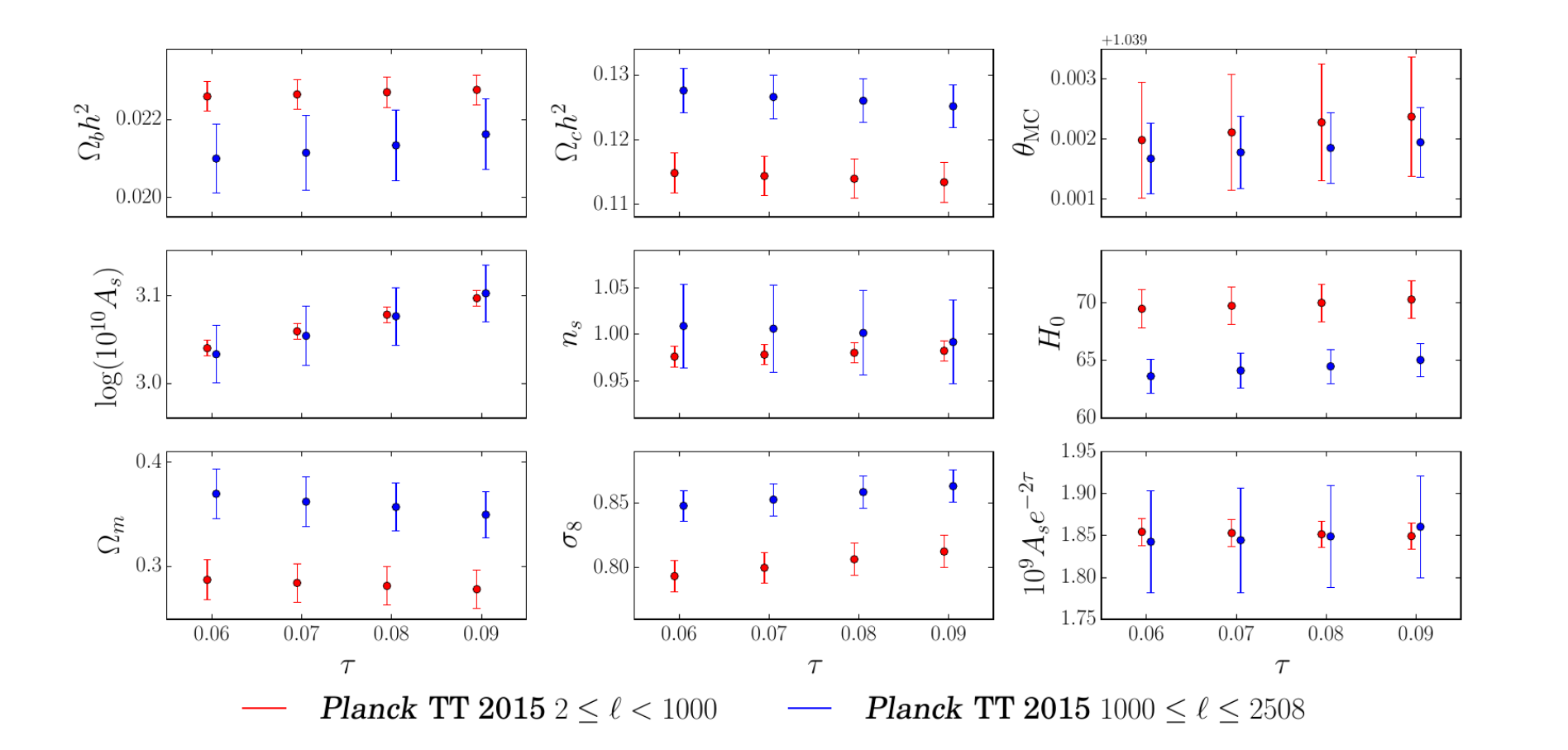
QUARKS-2018, May 2018

Tensions in σ_8 measurements



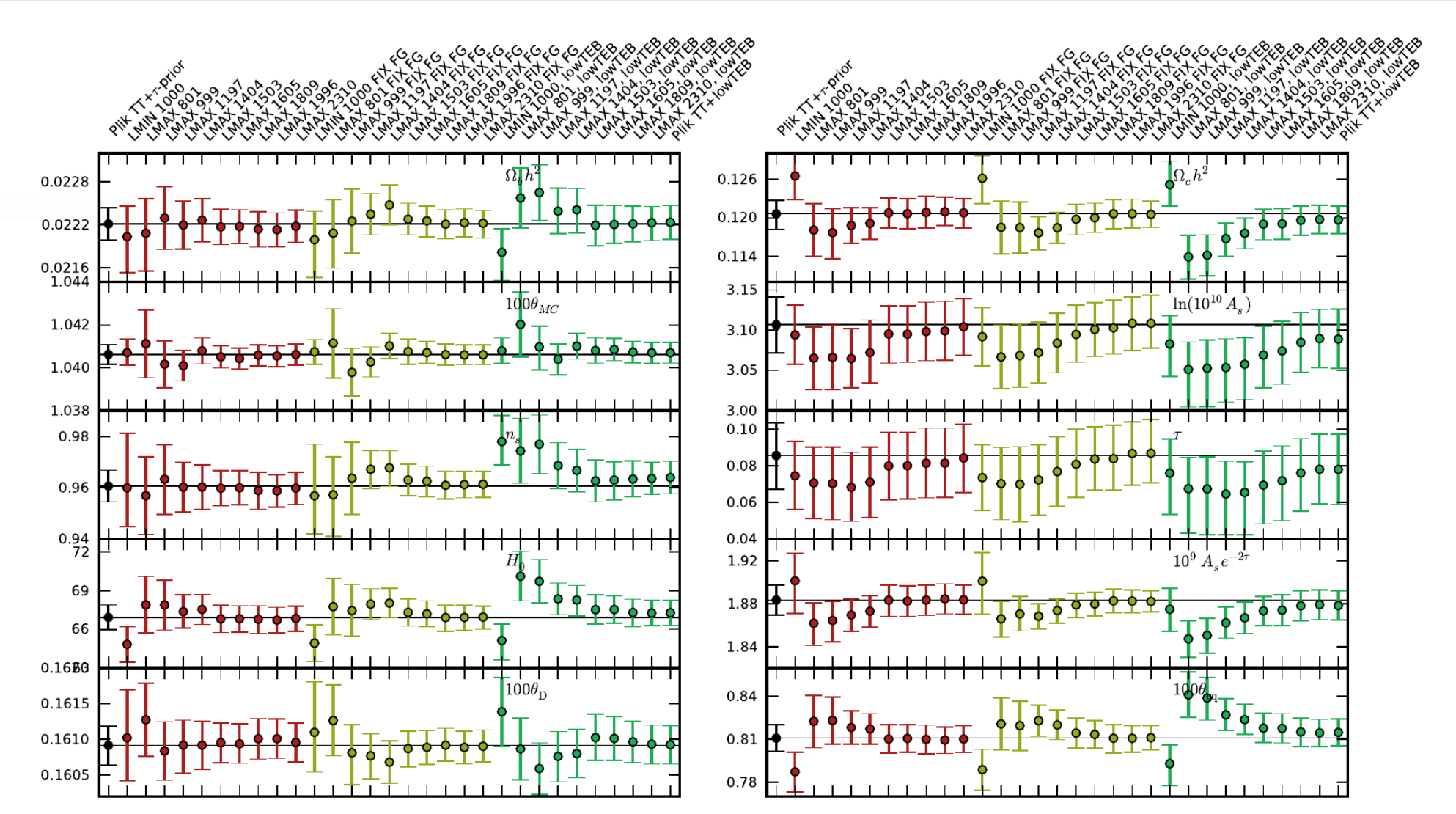
Planck-2013, XX

Shifts in cosmological parameters



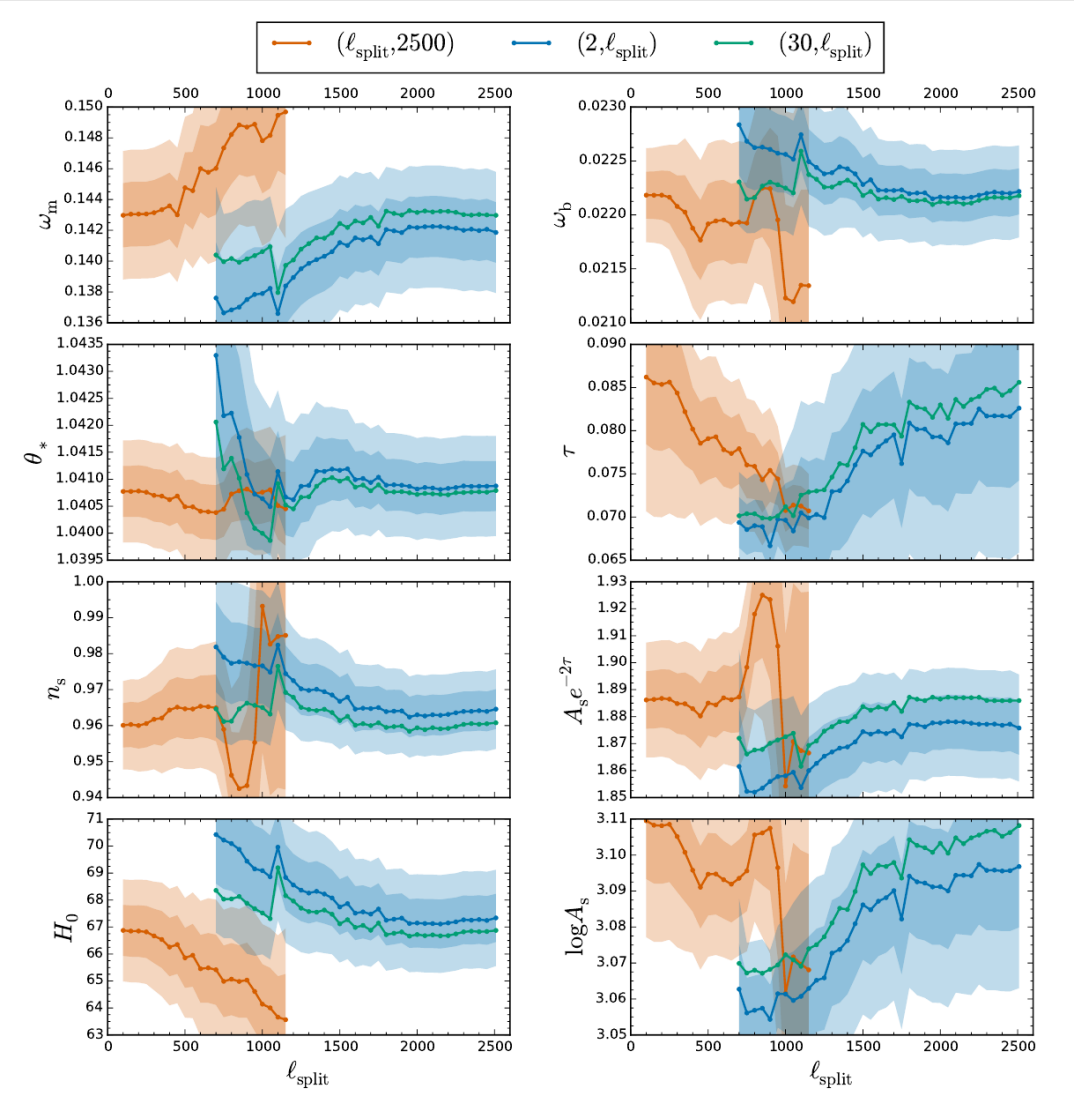
Addison et al., 2016

Shifts in cosmological parameters



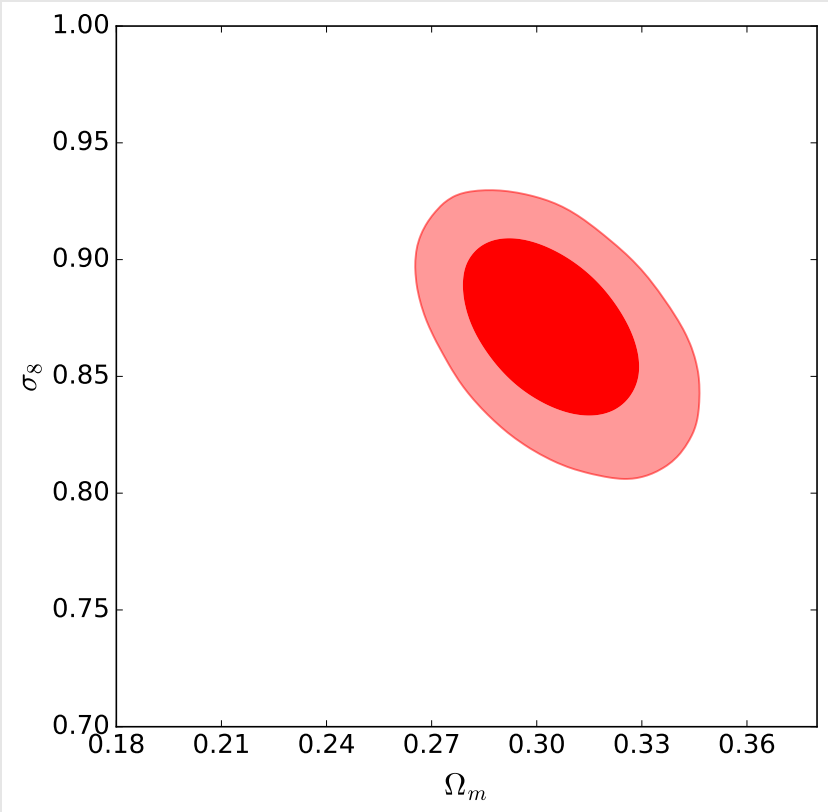
Planck-2015, XIII

Shifts in cosmological parameters



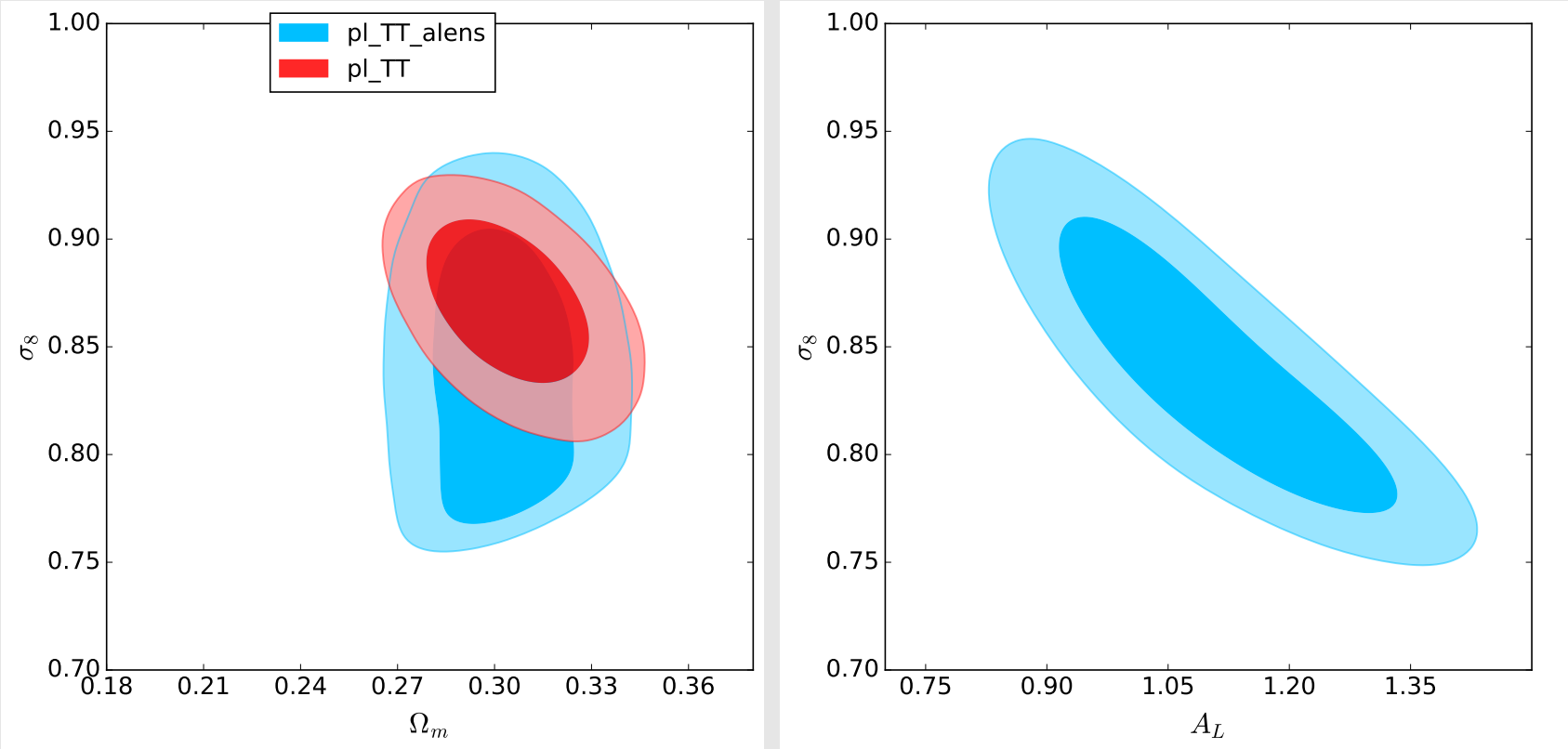
Planck intermediate results LI, A&A, 2017

Planck CMB temperature anisotropy spectrum



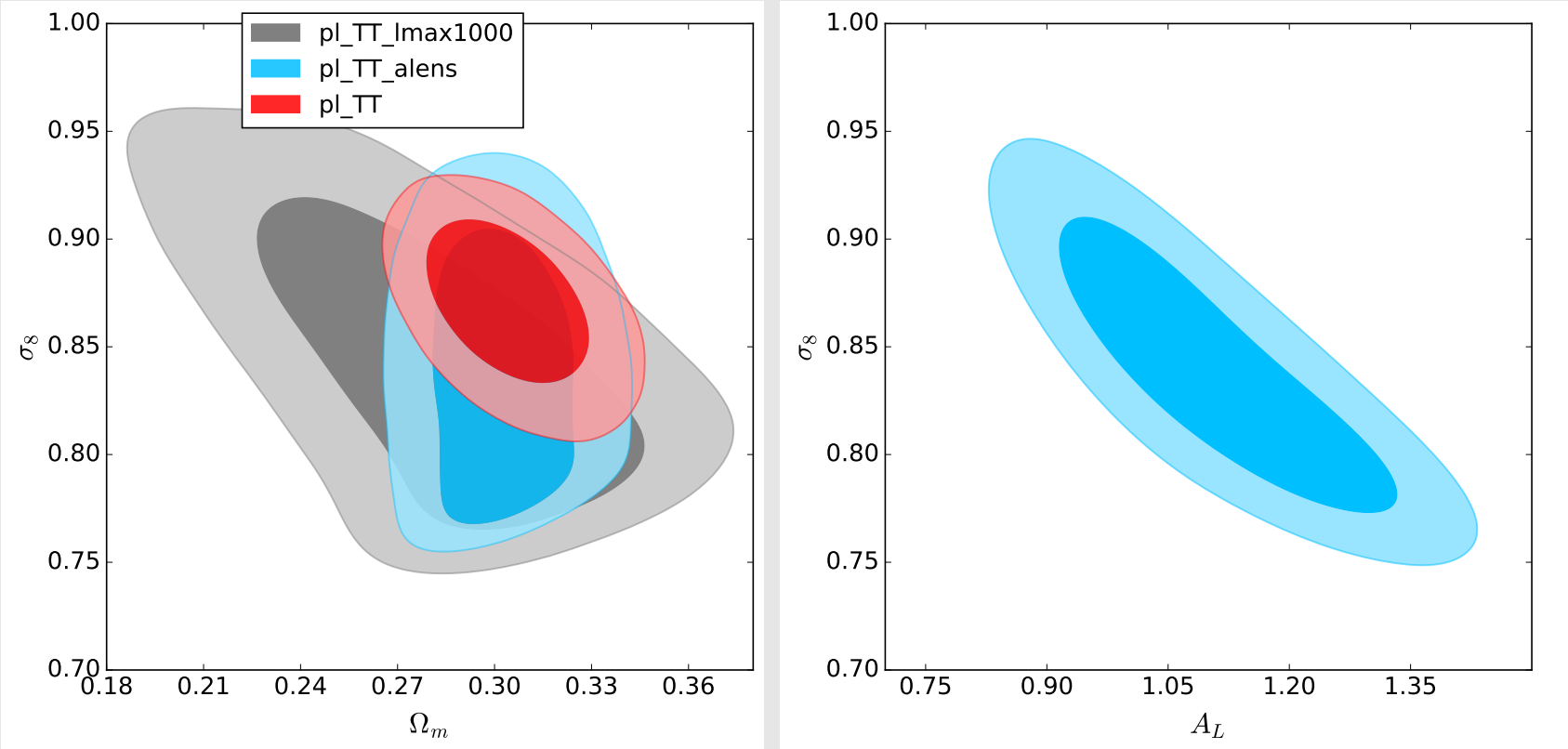
Planck CMB temperature anisotropy spectrum

free gravitational lensing amplitude, A_L



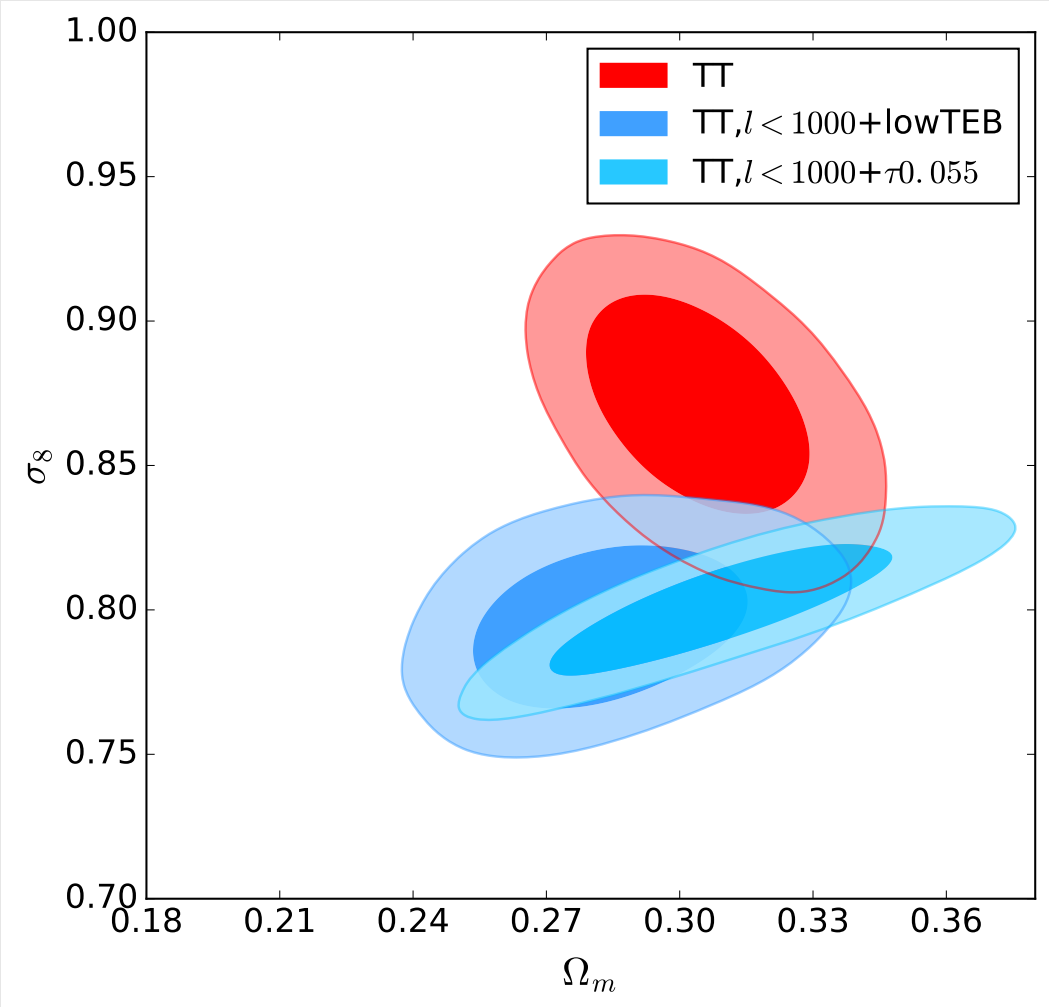
Planck CMB temperature anisotropy spectrum

free gravitational lensing amplitude, A_L, $\ell_{max} = 1000$

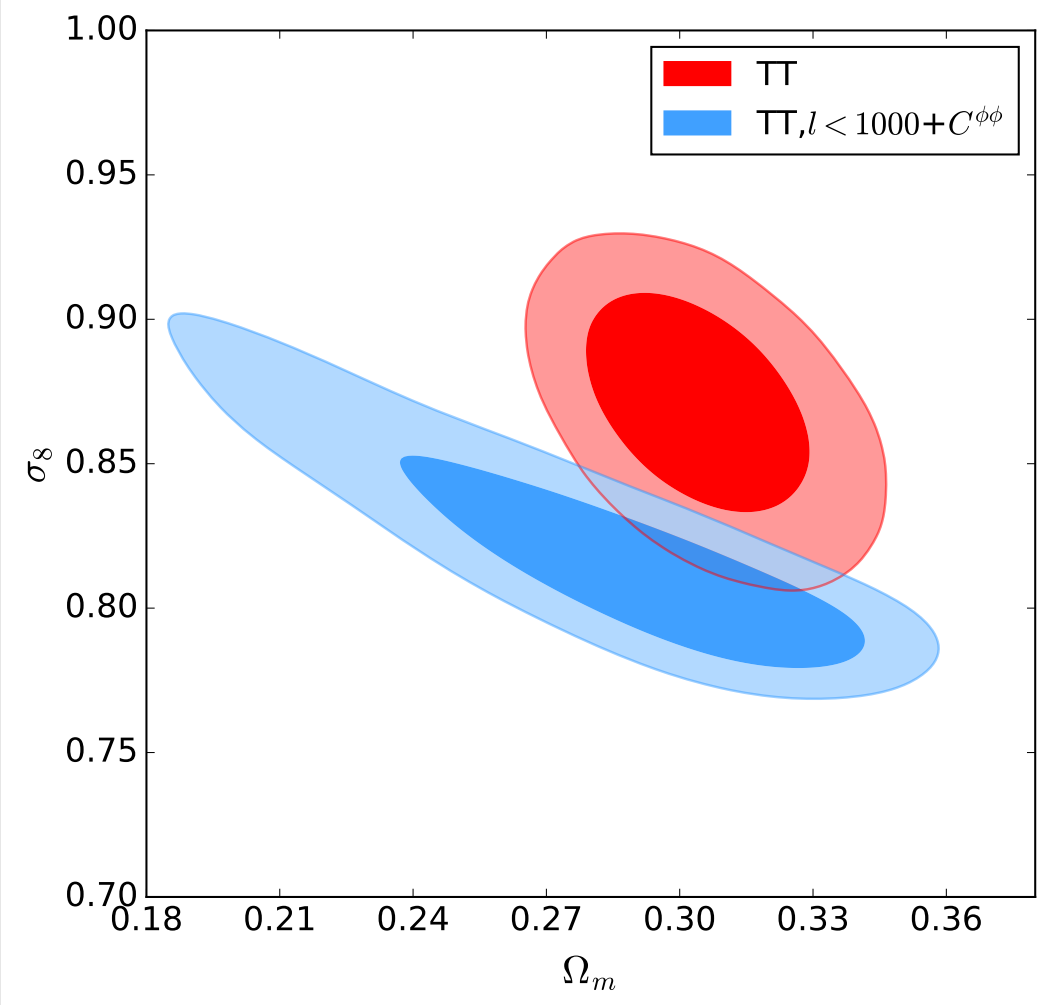


TT spectrum σ_8 constraint is based mainly on gravitational lensing measurement at $\ell > 1000$

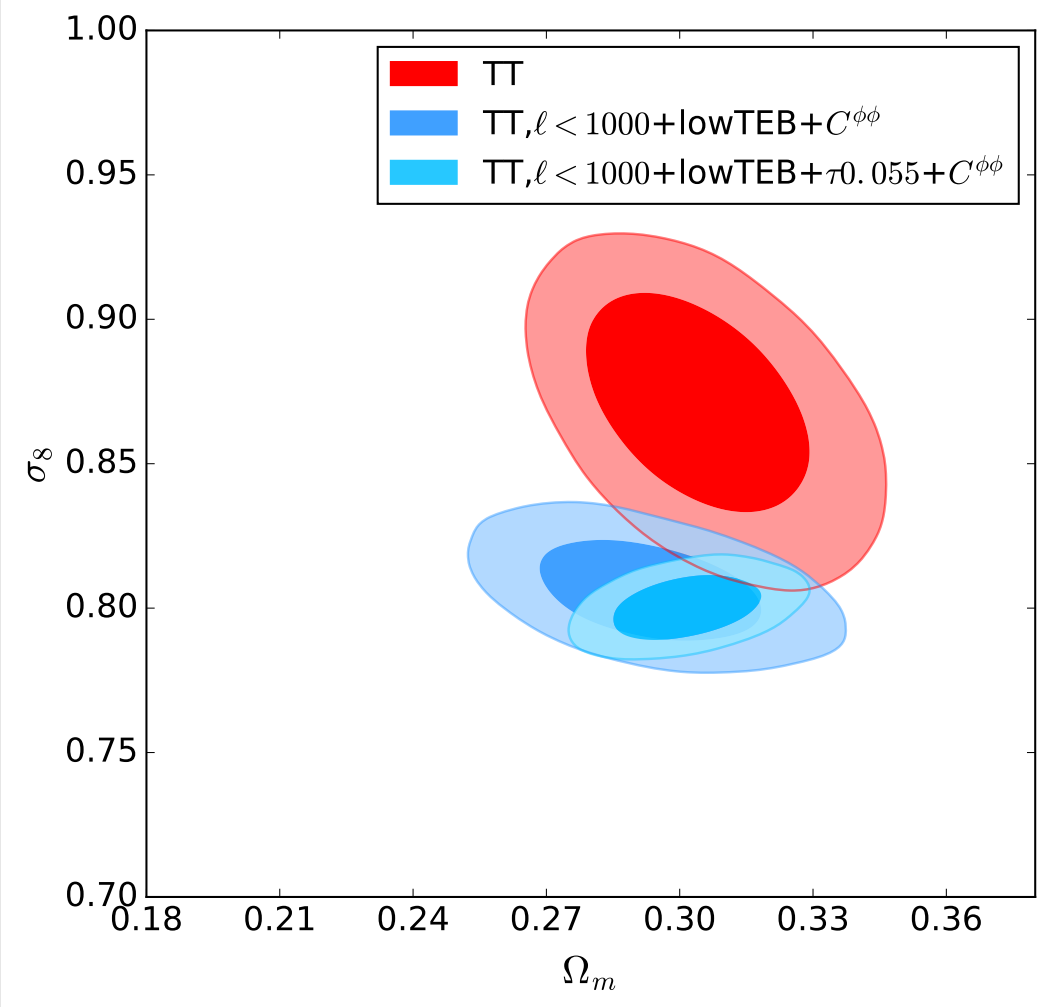
Planck polarization at low ℓ



Planck CMB gravitational lensing potential

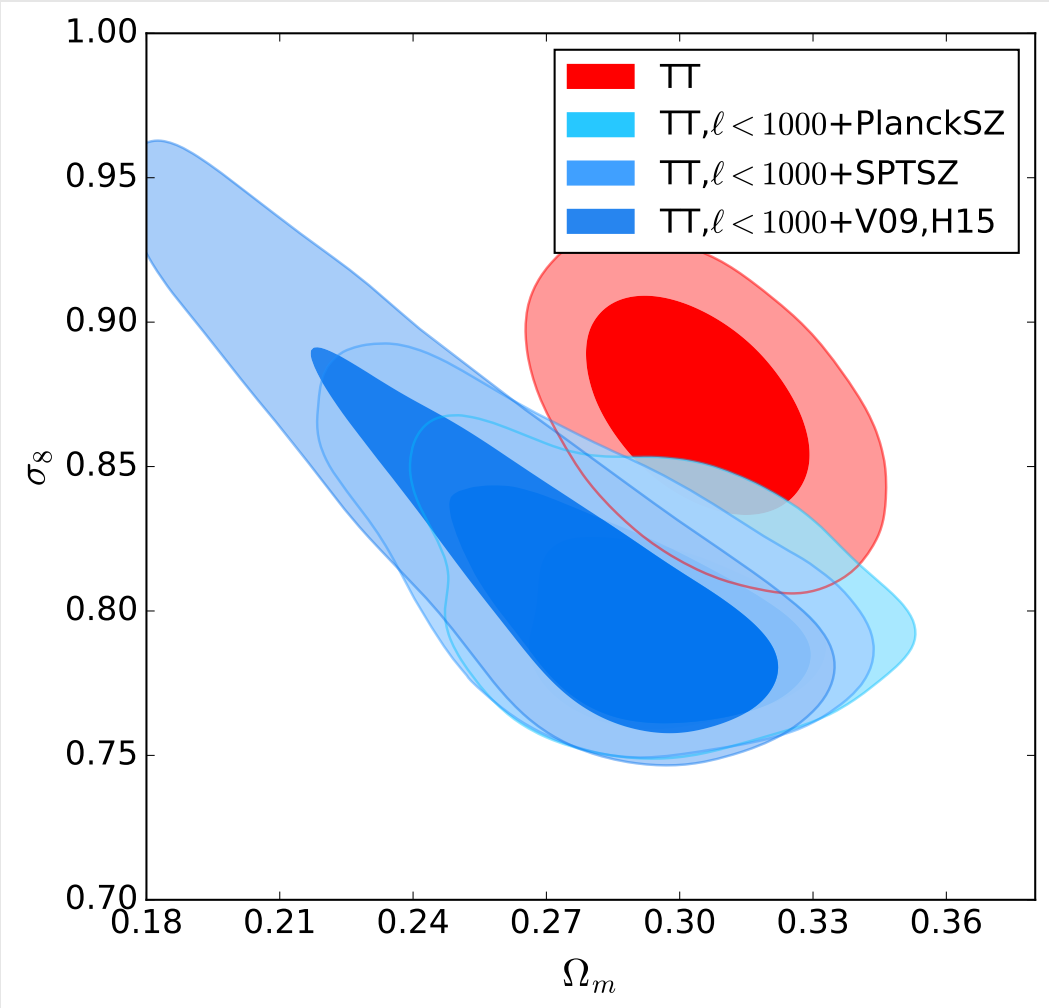


Planck low ℓ polarization + lensing potential



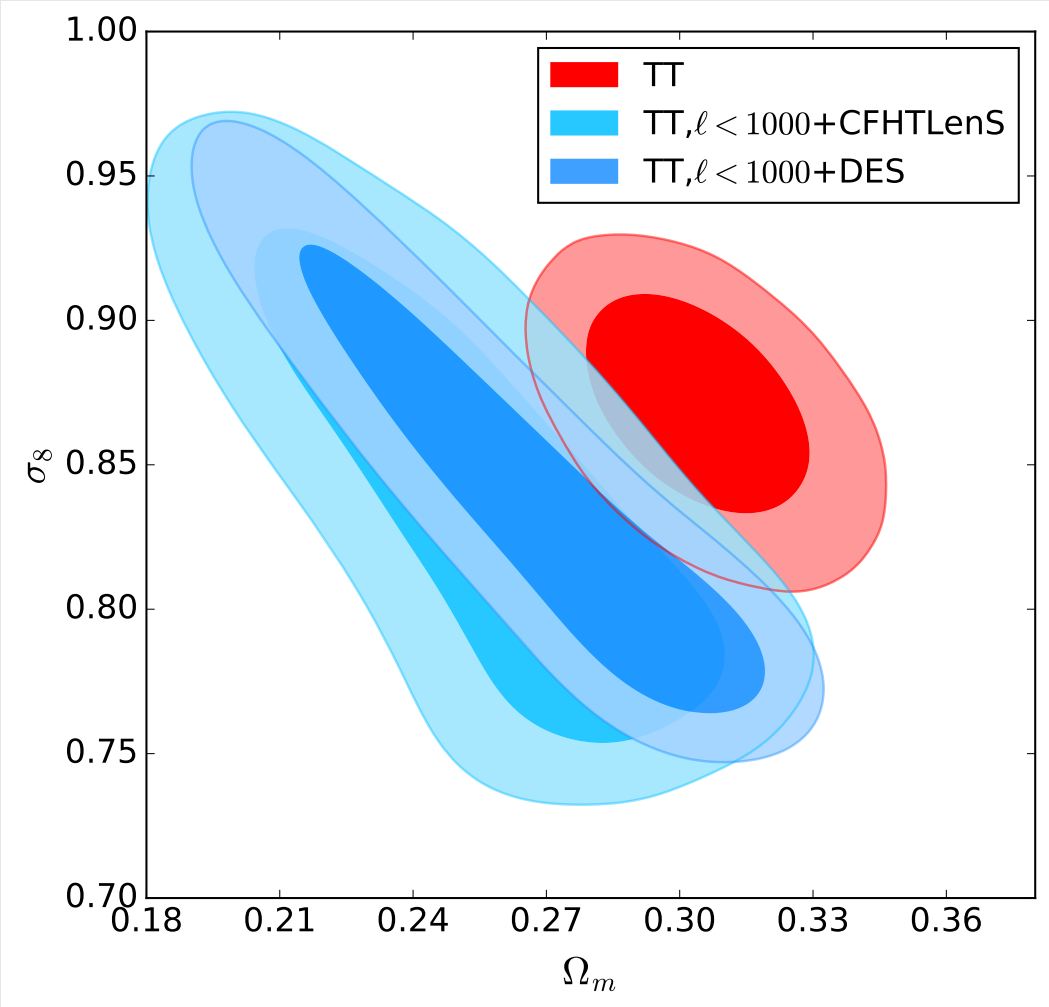
$\approx 2.7\sigma$ tension with TT at $\ell > 1000$

Galaxy cluster mass function



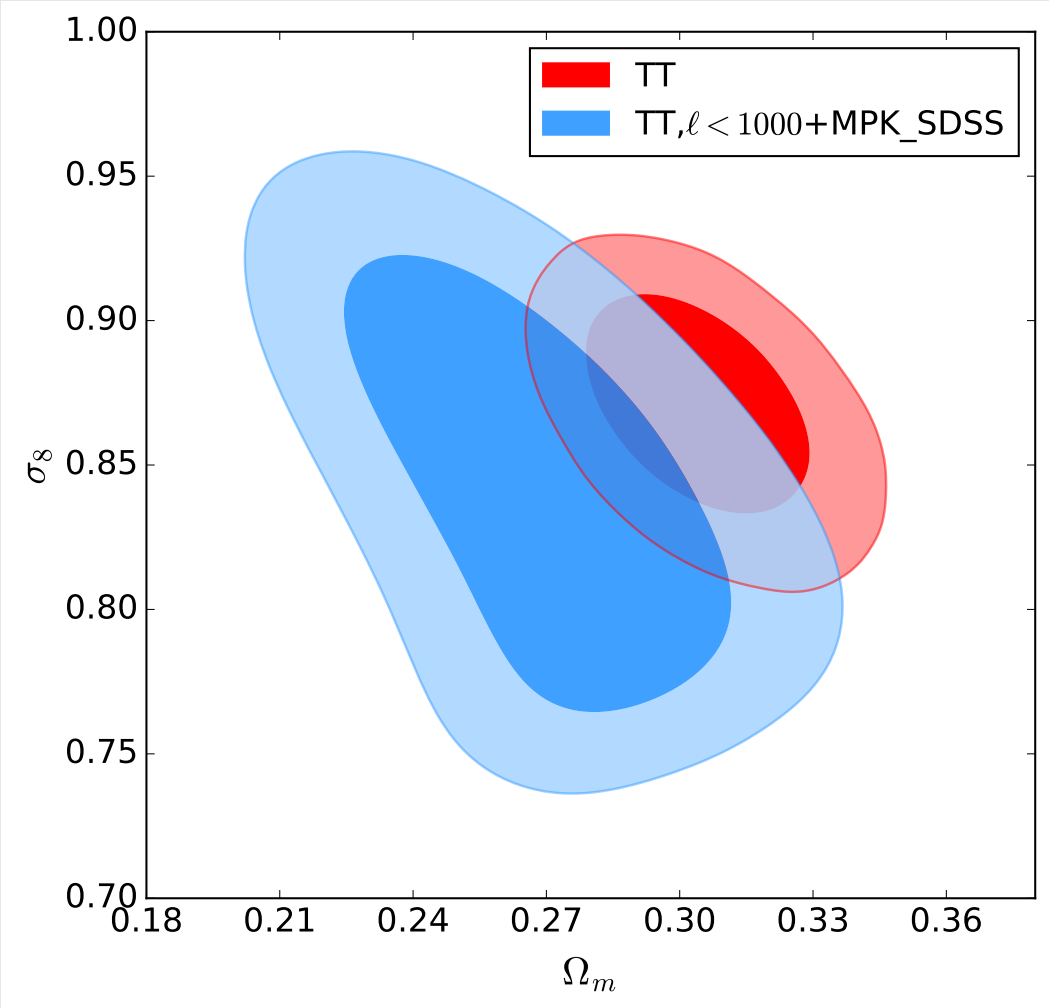
Planck-SZ, SPT-SZ, Vikhlinin et al., 2009 + Hoekstra et al., 2015

Weak gravitational lensing



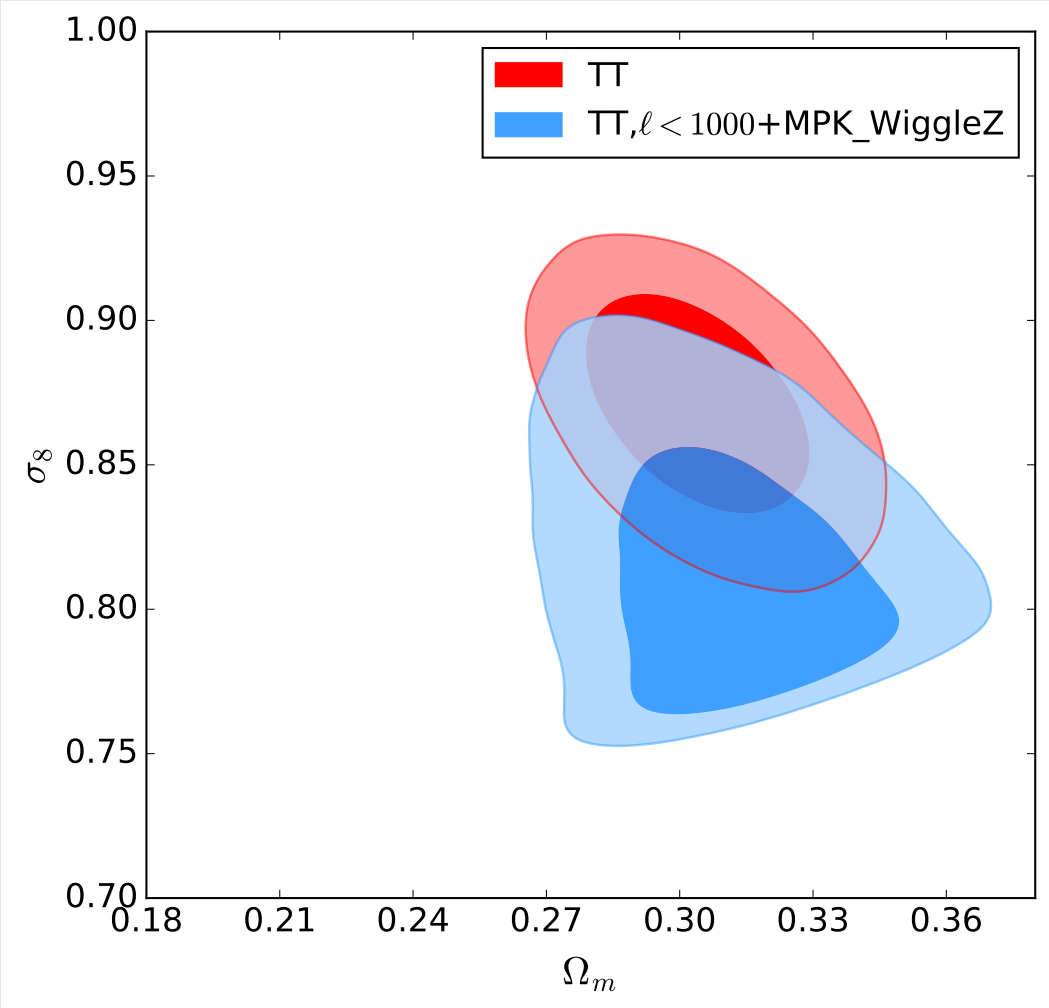
CFHTLenS, DES-1yr

Matter power spectrum



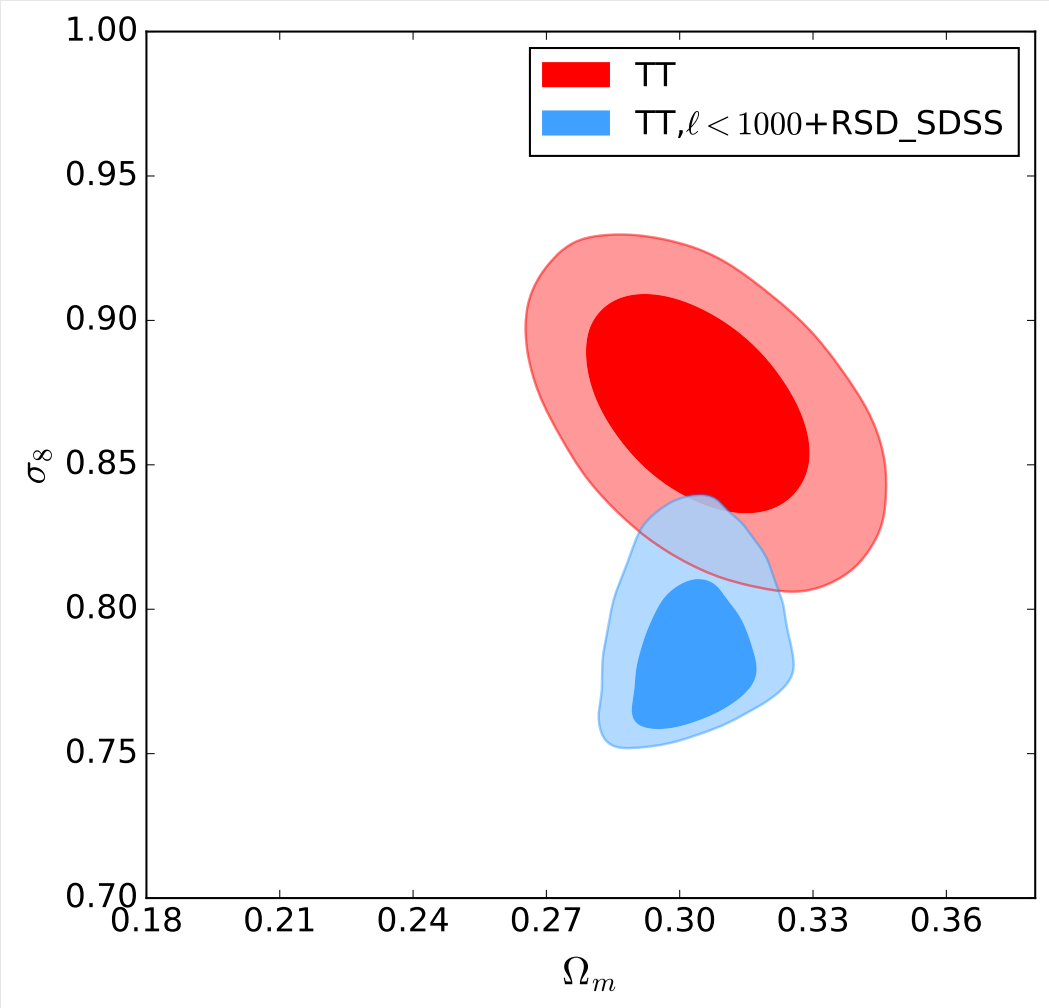
SDSS-dr4

Matter power spectrum (+BAO)



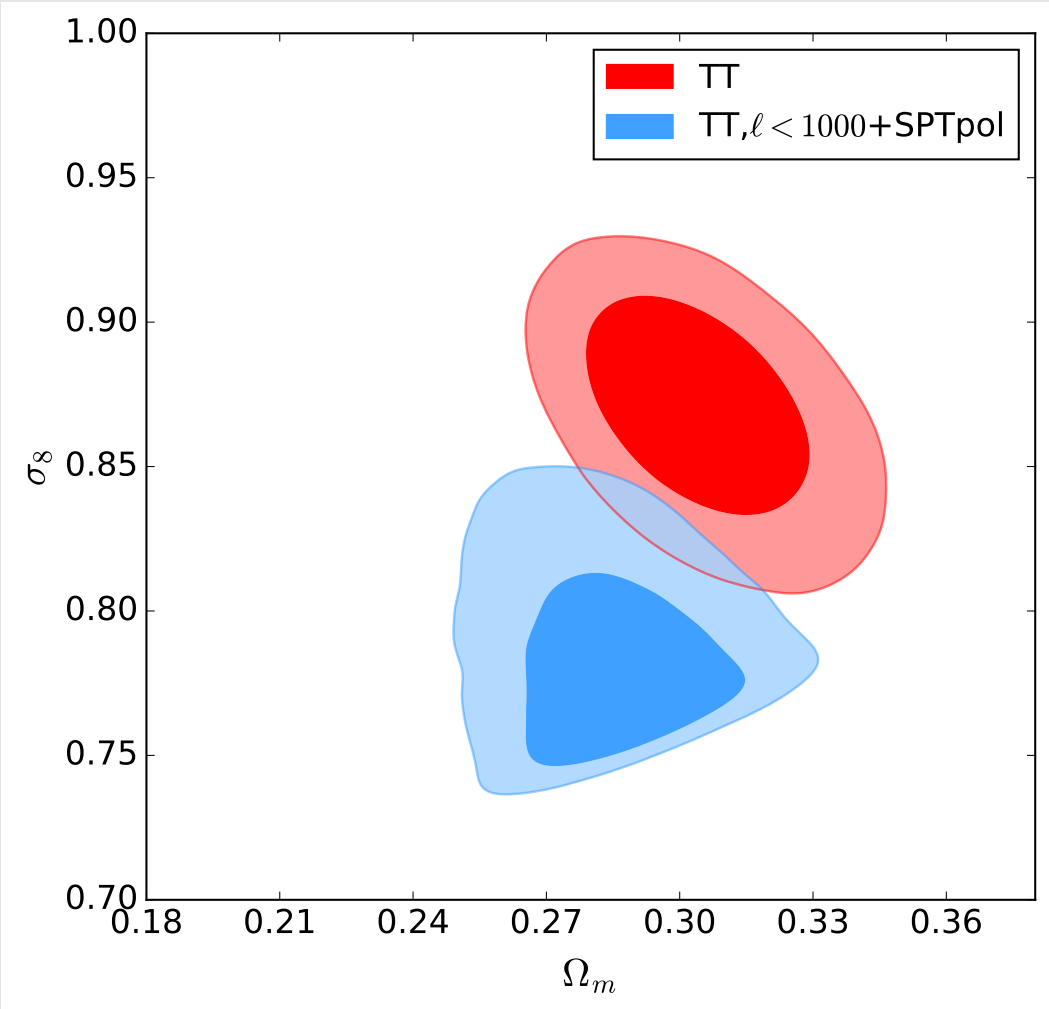
WiggleZ

Redshift space distorsions (+BAO)



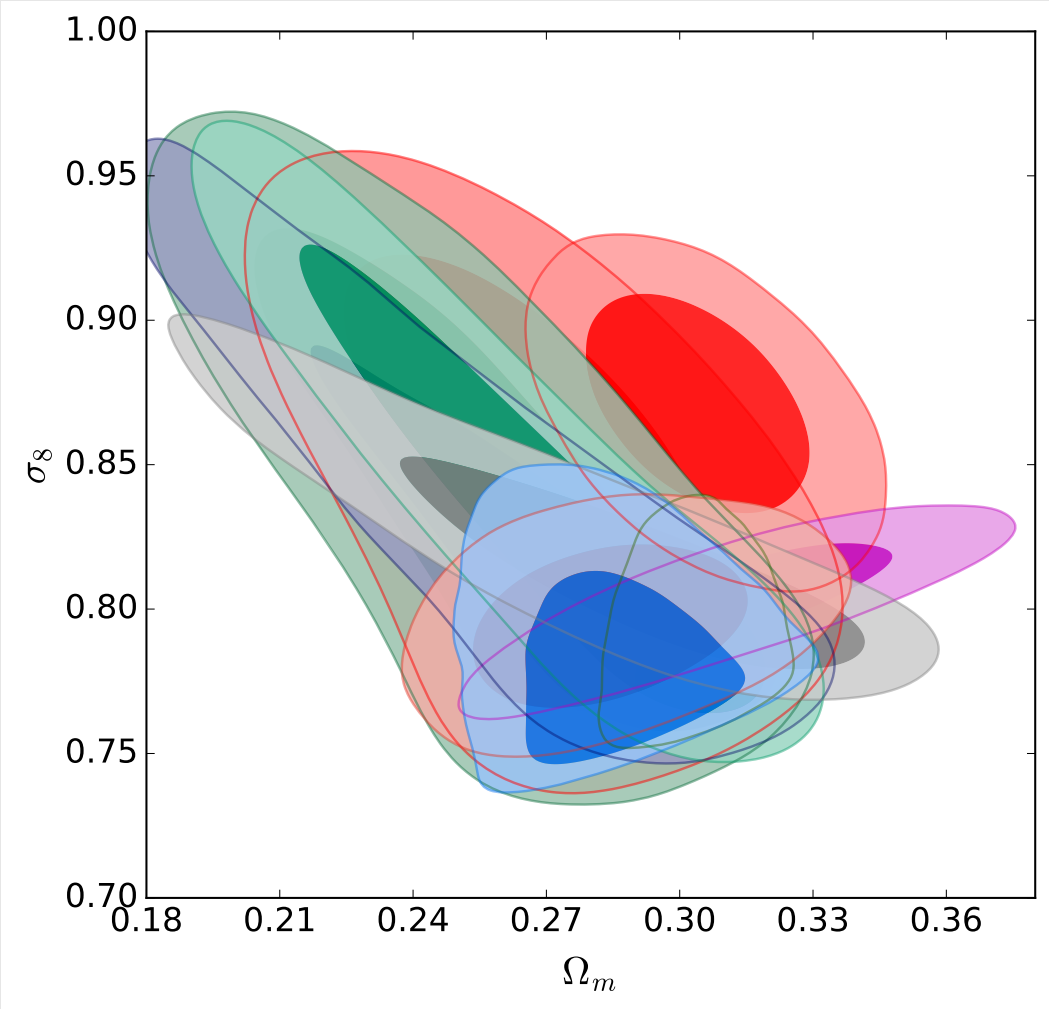
SDSS-dr12

South Pole Telescope CMB polarization anisotropy

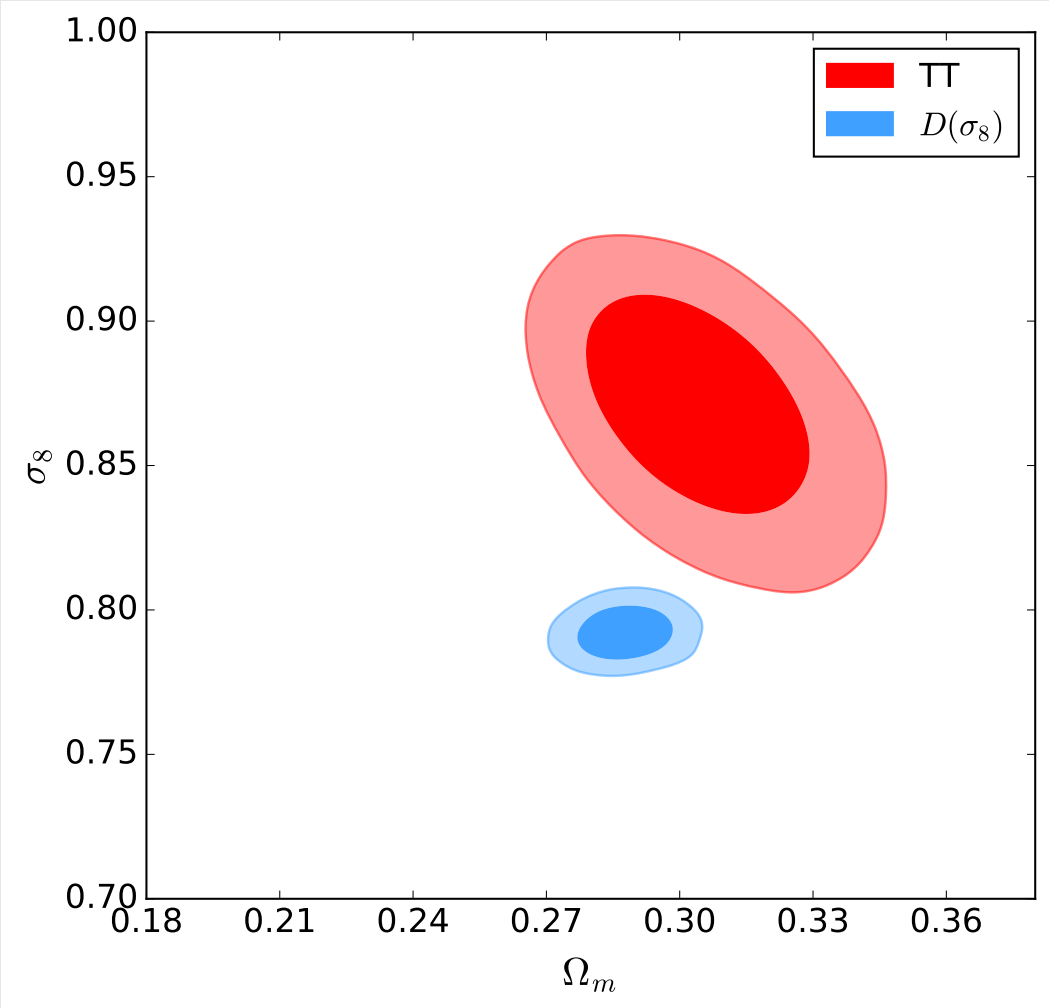


SPTpol, EE,TE

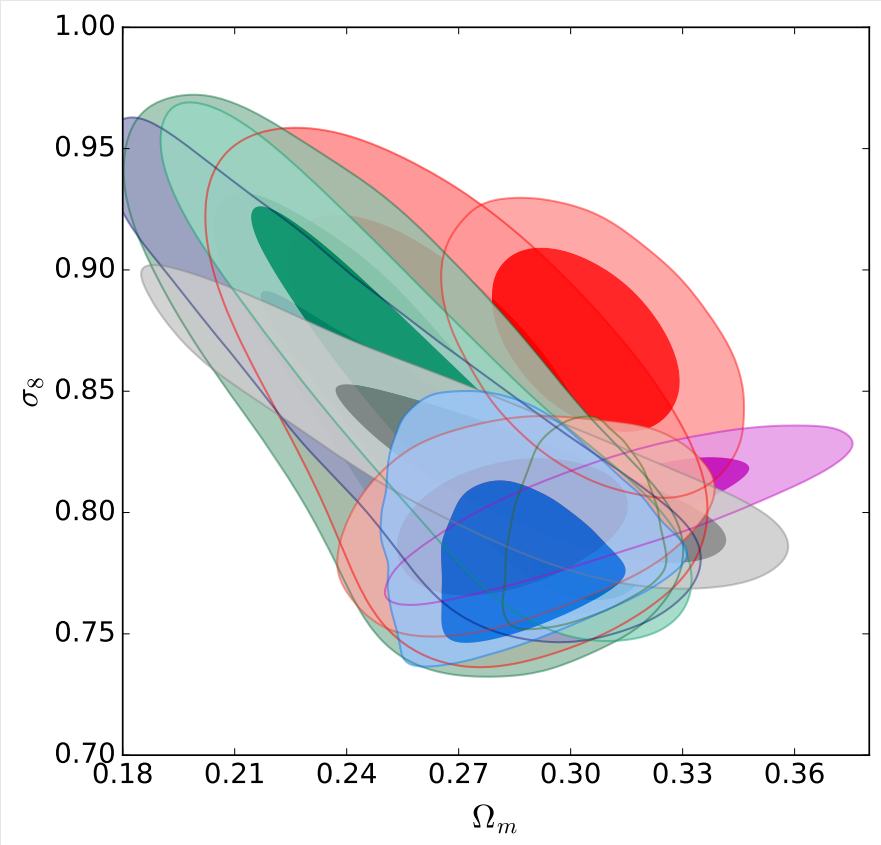
All σ_8 measurements

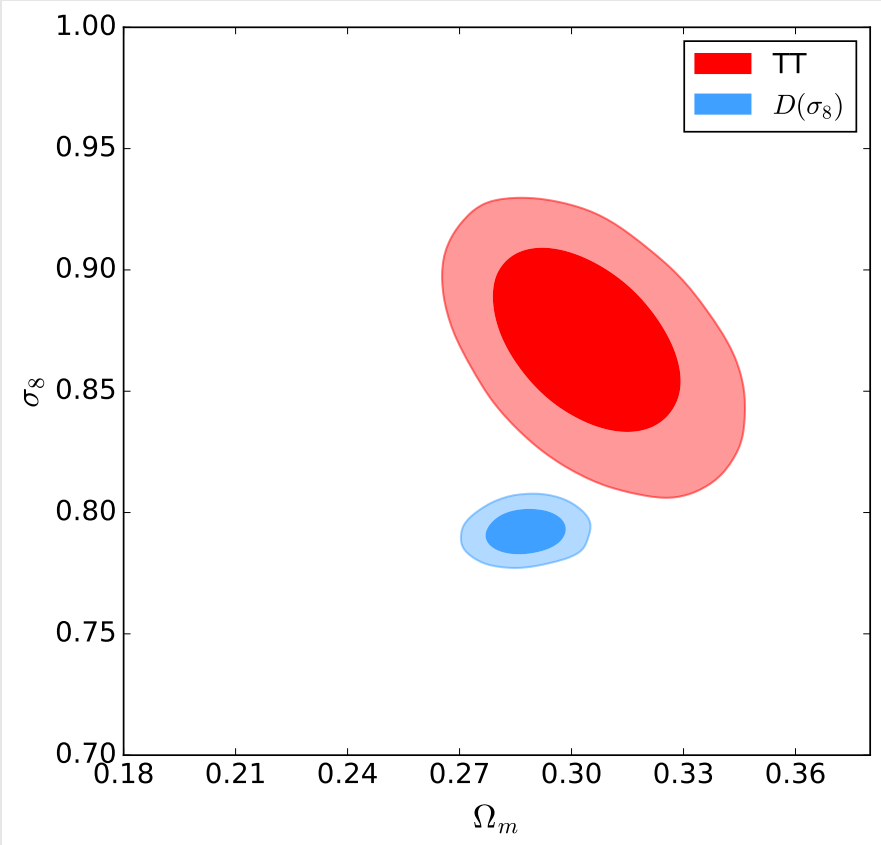


All σ_8 measurements combined



Combined σ_8 measurements

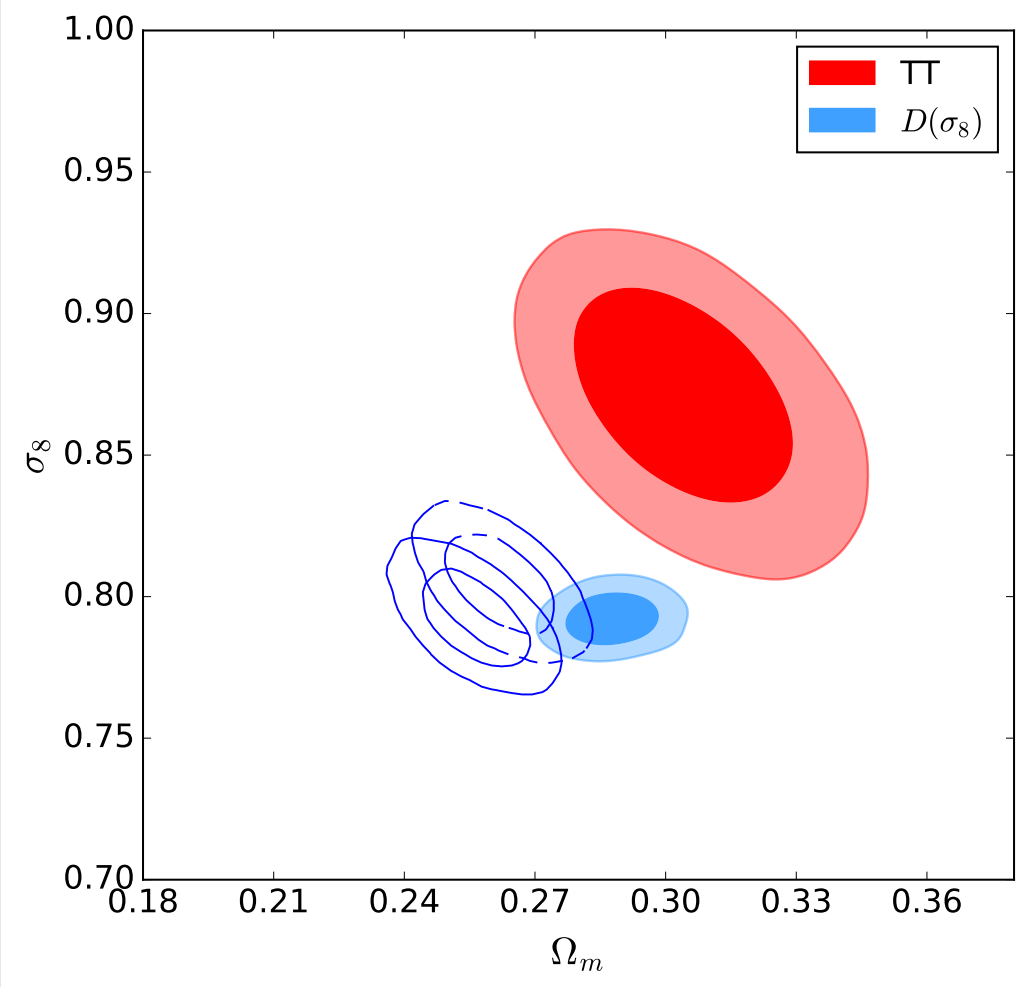




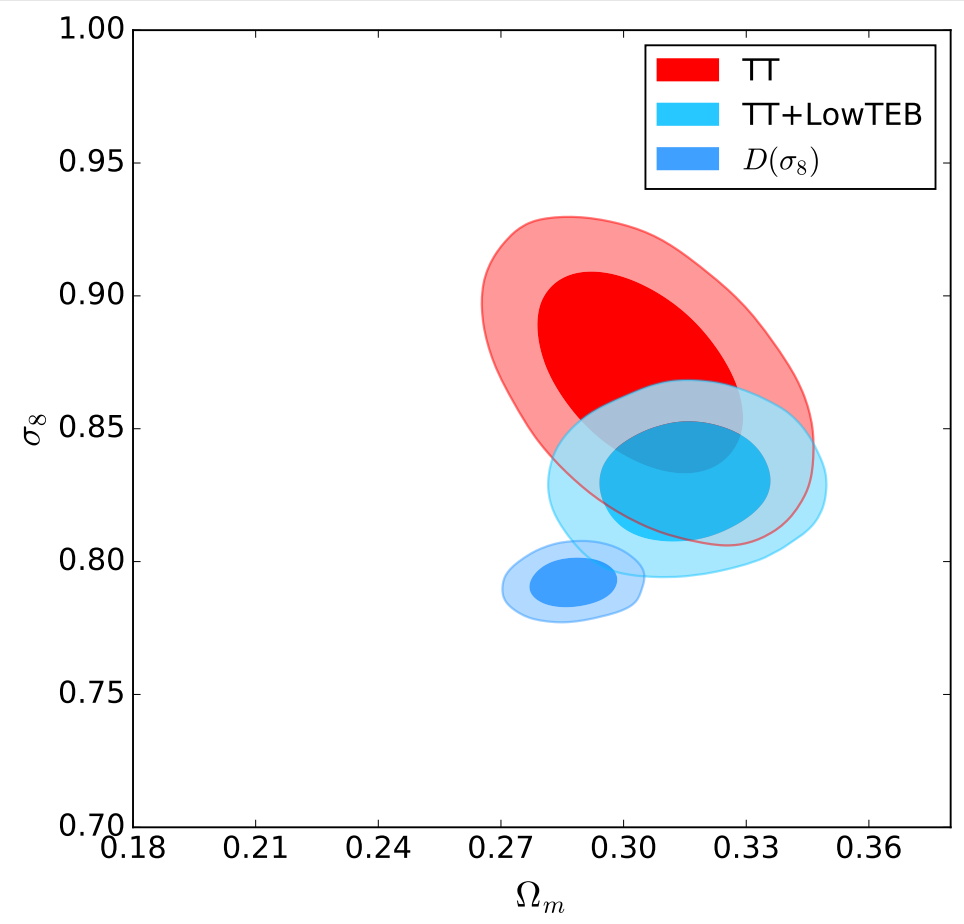
σ_8 constraints from *Planck* CMB TT data at, $\ell > 1000$, *contradicts* to all other constraints obtained both from remaining *Planck* CMB anisotropy data and from other cosmological data — $D(\sigma_8)$ dataset, — at $\approx 3.7\sigma$ level — these data should not be combined together!

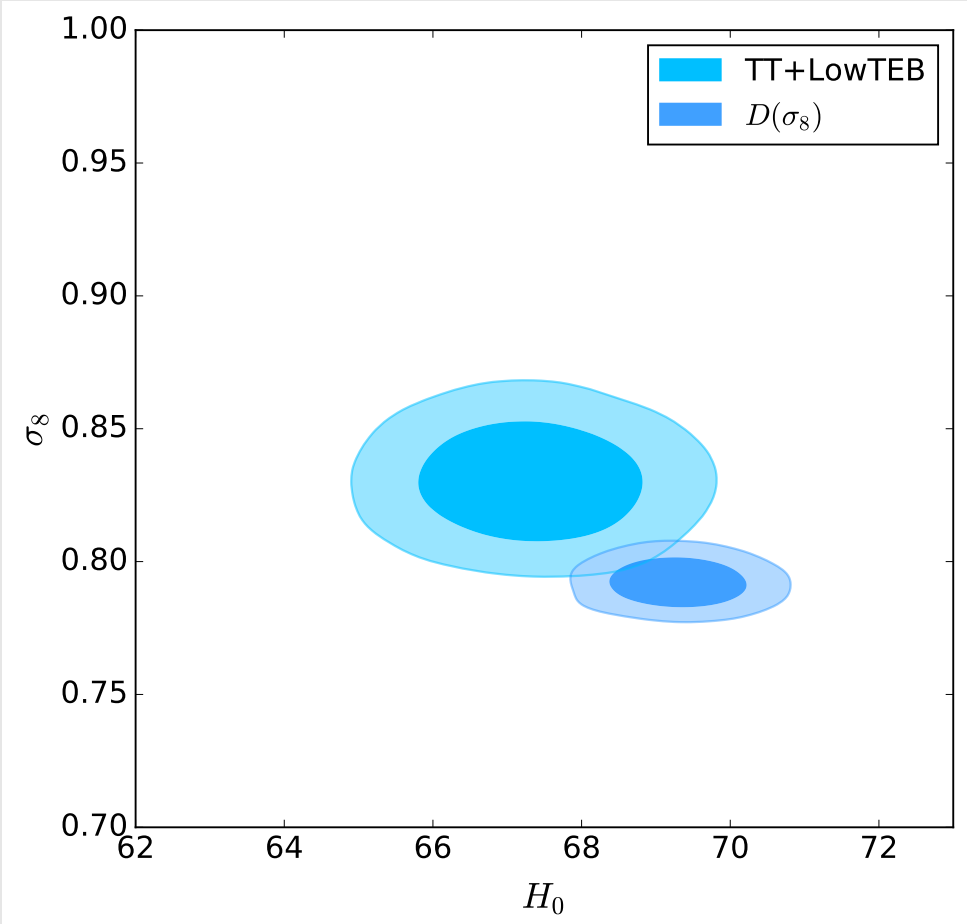
Combined σ_8 measurements

are in a good agreement with pre-*Planck* results from RB and A. Vikhlinin, 2012



Combined σ_8 measurements

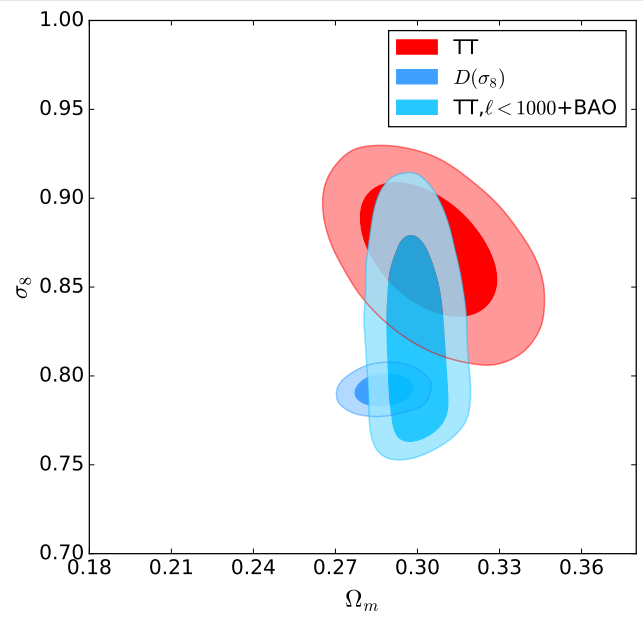




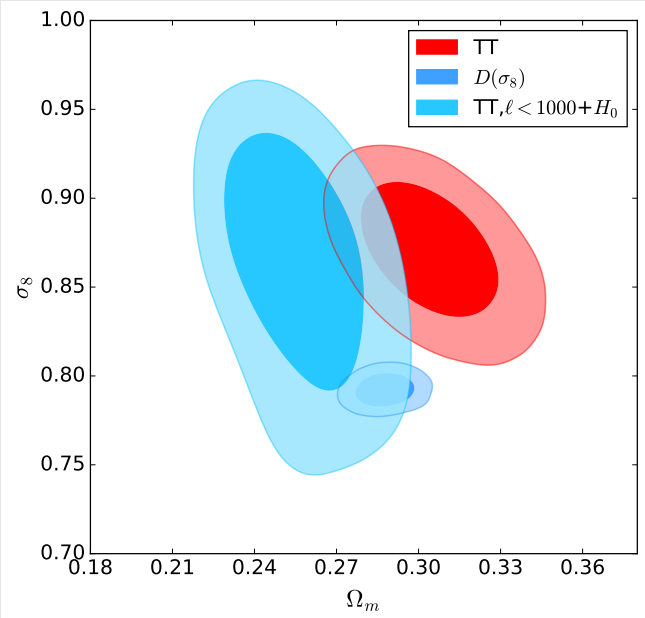
$\sigma_8 = 0.792 \pm 0.006$, $\Omega_m = 0.288 \pm 0.007$, $H_0 = 69.3 \pm 0.61$ km s^{-1} Mpc^{-1}

Distances and expansion rate

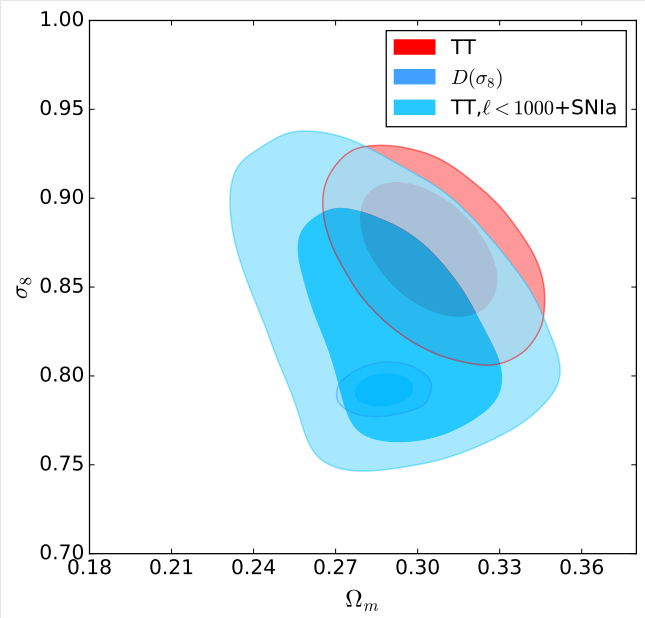
BAO:



local H_0:

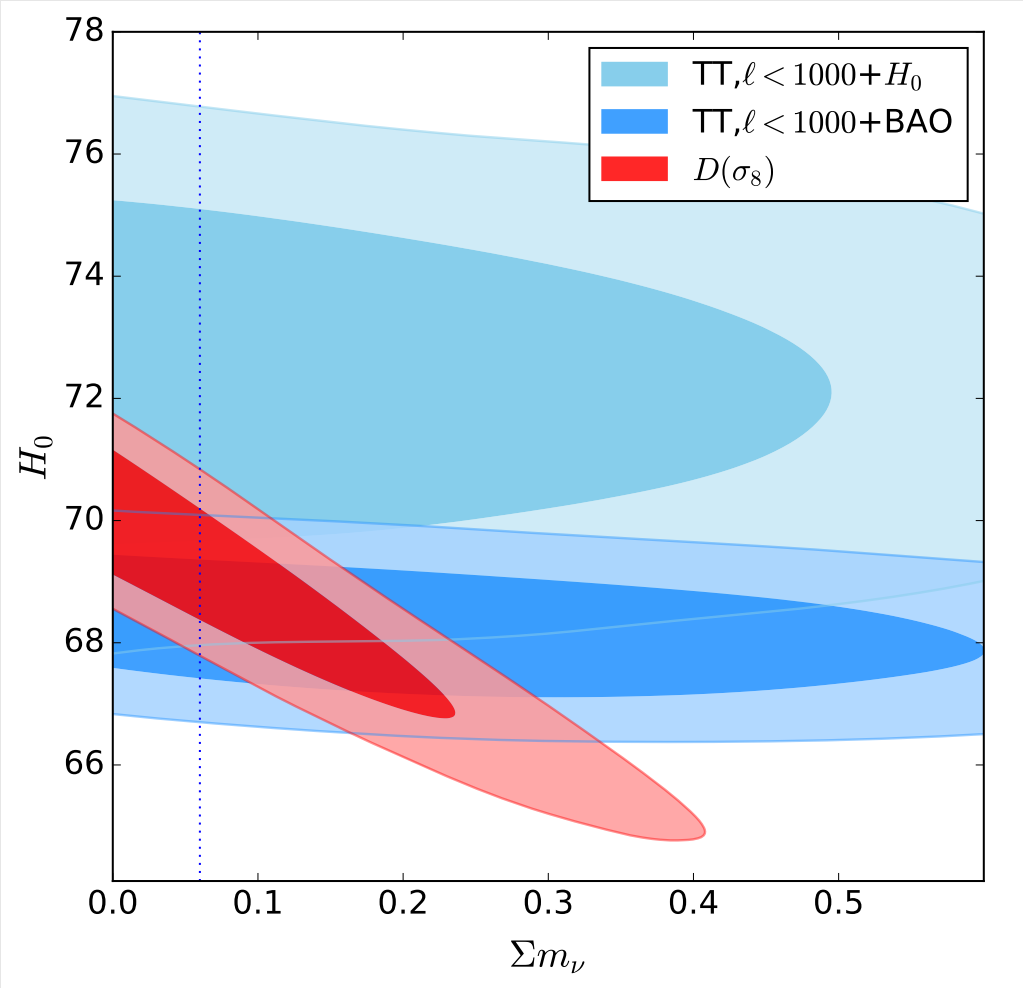


SN Ia:



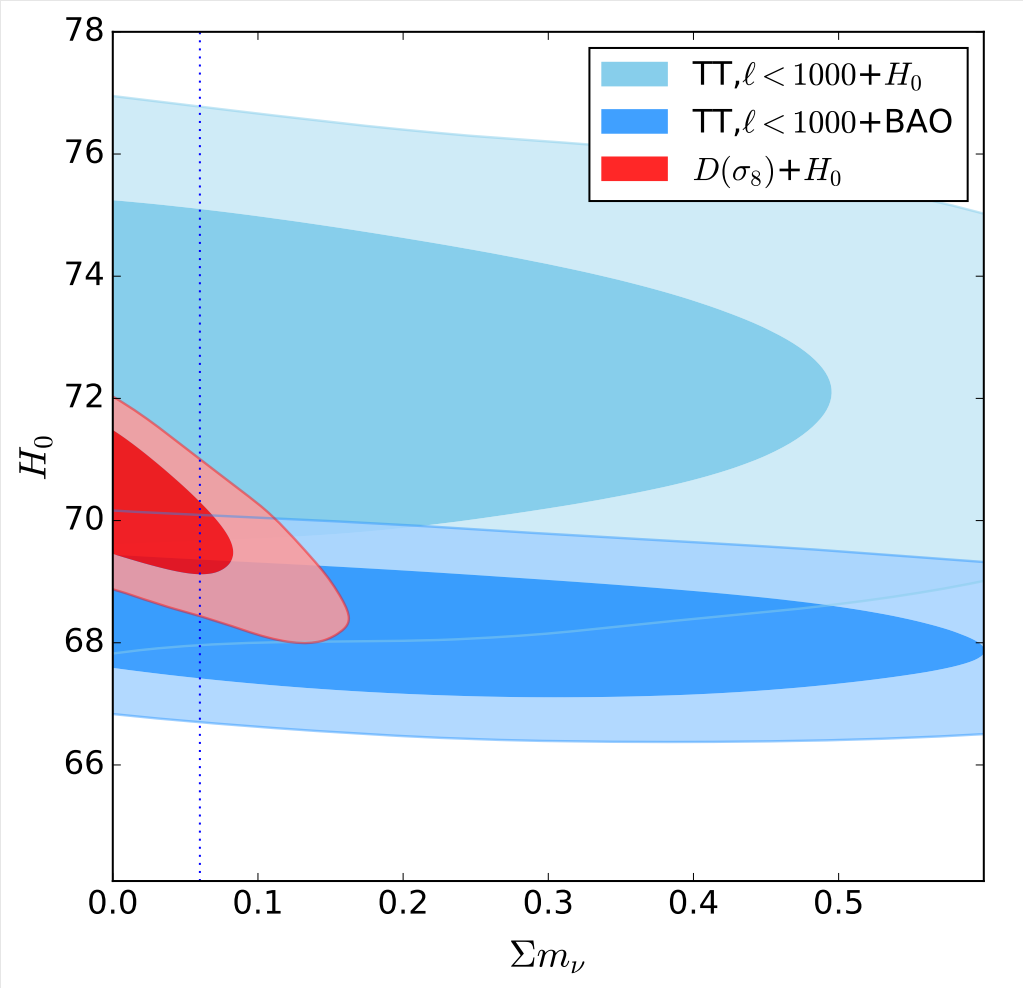
ΛCDM + Σm_ν

all σ_8 measurements, BAO and H_0 (+ TT, $\ell < 1000$)



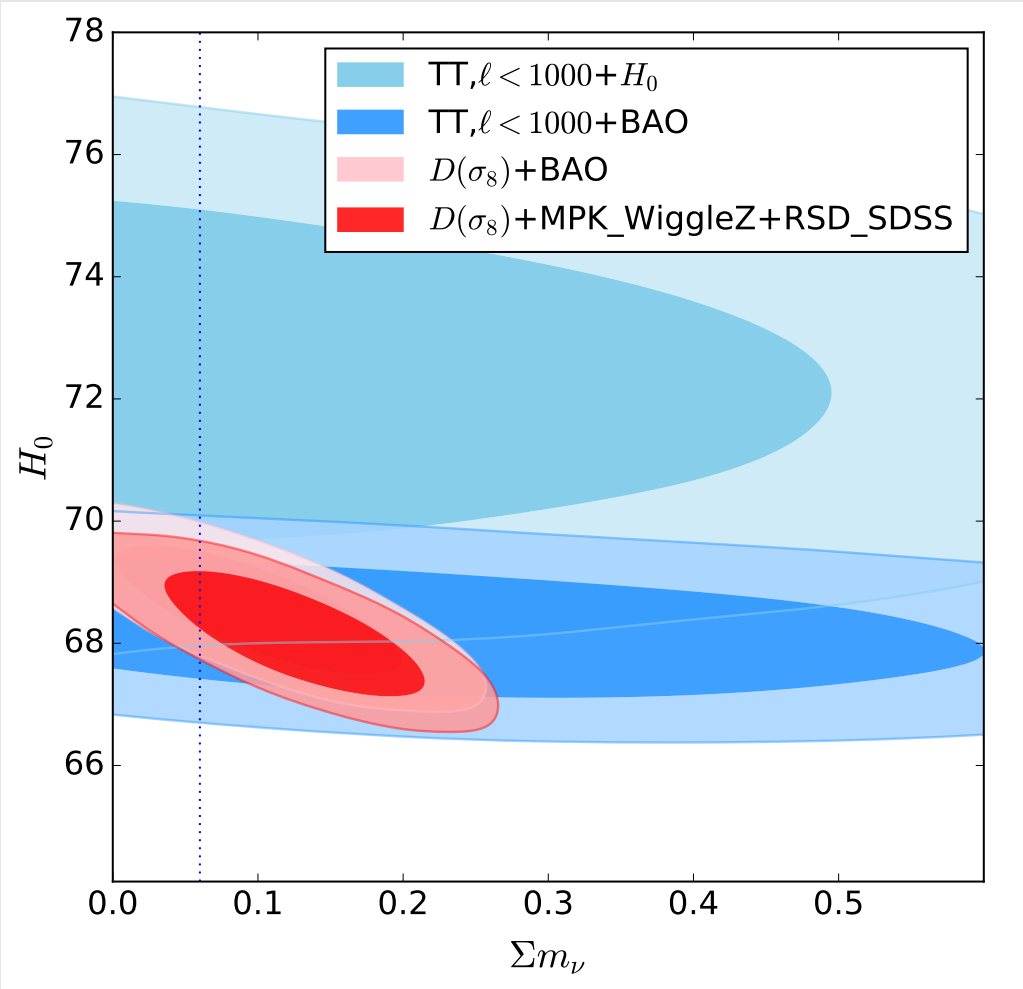
ΛCDM + Σm_ν

all σ_8 measurements + H_0: $\Sigma m_\nu < 0.122$ eV (95%)



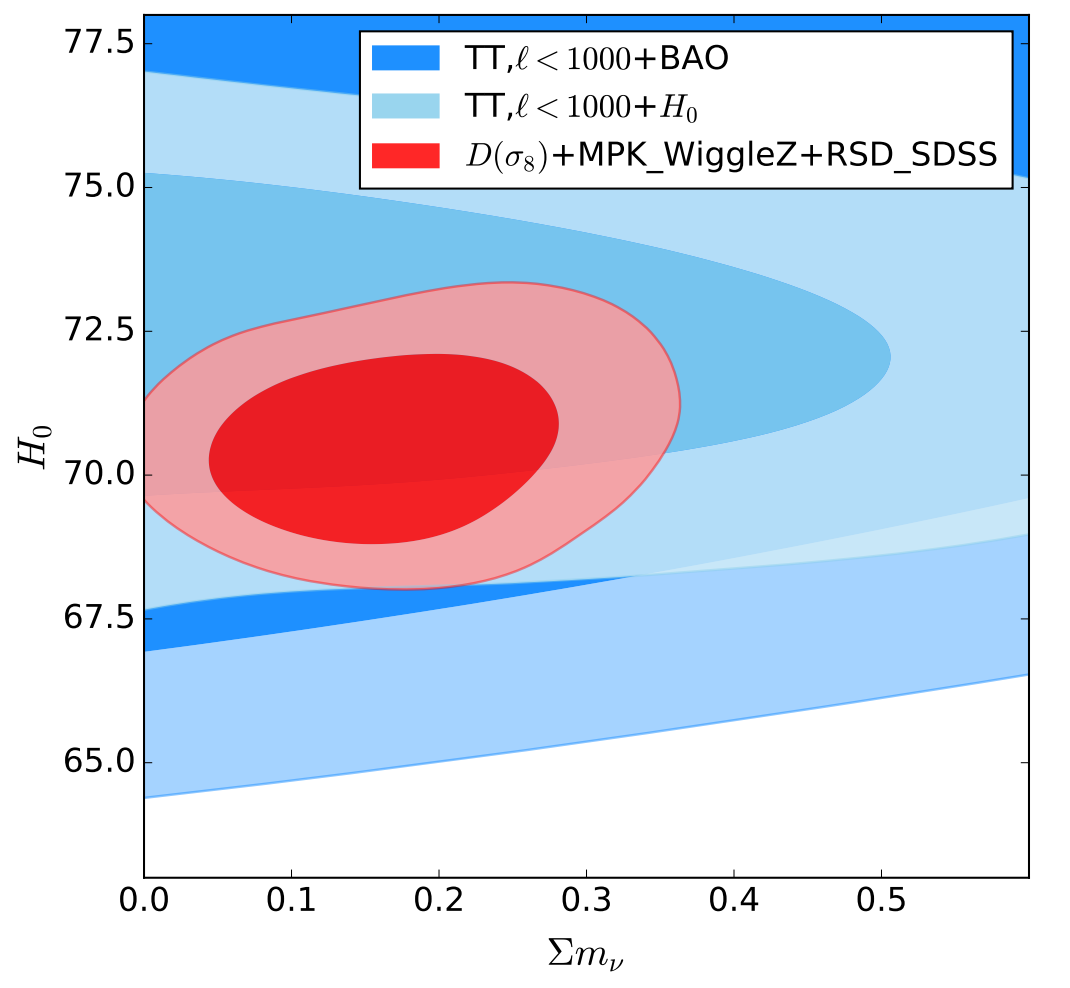
ΛCDM + Σm_ν

all σ_8 measurements + BAO: $\Sigma m_\nu = 0.128 \pm 0.057$ eV

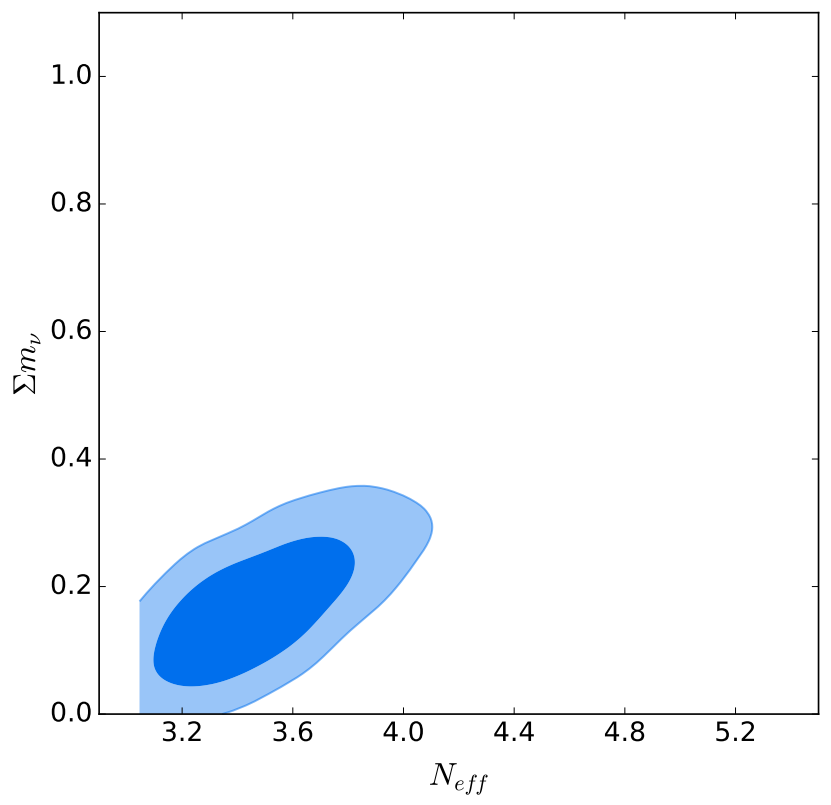


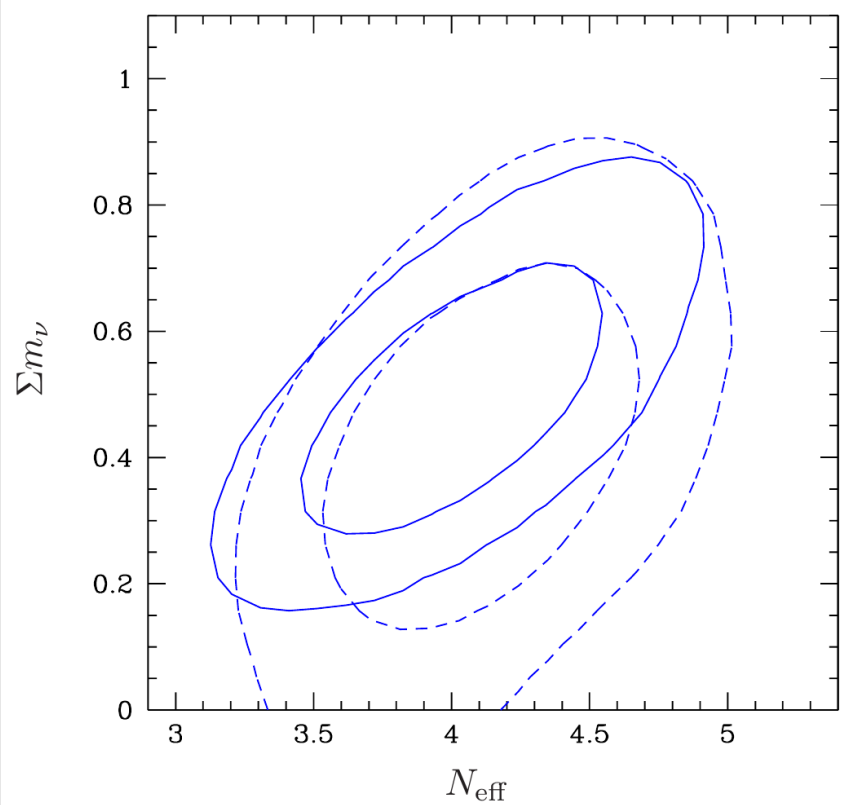
ΛCDM + Σm_ν + N_{eff}

all σ_8 measurements + H_0, + BAO: $\Sigma m_\nu = 0.173 \pm 0.078$ eV, $N_{\rm eff.} = 3.49 \pm 0.24$



ΛCDM + Σm_ν + N_{eff}





$\approx 1\sigma$ shift

RB, AstL, 2013

Conclusions

- The measurement of matter density perturbations amplitude from *Planck* TT data at high multipoles, $\ell > 1000$, *contradicts* to all other measurements obtained both from remaining Planck CMB anisotropy data and from other cosmological data, at about 3.7σ significance level.

  These data should not be combined together!

- The remaining data (*lowTEB*, $C^{\phi\phi}$, clusters, *WL*, *MPK*, *RSD*, *SPTpol*) are in good agreement amoung each other and give: $\sigma_8 = 0.792 \pm 0.006$, $\Omega_m = 0.288 \pm 0.007$, and $H_0 = 69.3 \pm 0.61$ km s^{-1} Mpc^{-1}

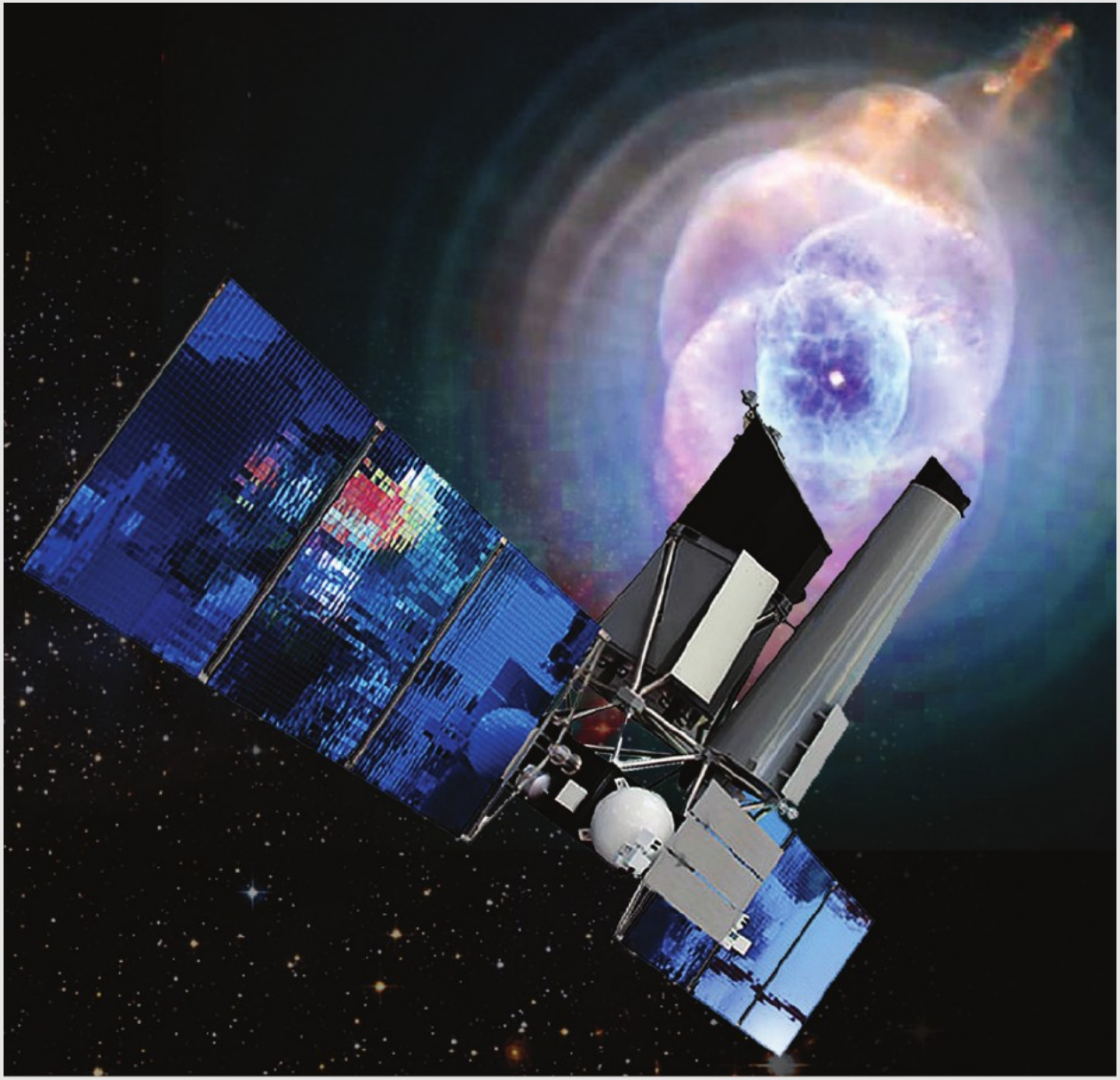
- Taking in account the data on baryon acoustic oscillations and (or) direct measurements of the Hubble constant in the local Universe, the following constraints are obtained:

  all σ_8 data + H_0: $\Sigma m_\nu < 0.122$ eV (95%)

  all σ_8 data + BAO: $\Sigma m_\nu = 0.128 \pm 0.057$ eV

  all σ_8 data + H_0 + BAO: $\Sigma m_\nu = 0.173 \pm 0.078$ eV, $N_{\rm eff.} = 3.49 \pm 0.24$

Spectrum Roentgen Gamma



$\sim$100 000 galaxy clusters

Launch date: March 2019