Comparing Cosmological Constraints form X-ray Galaxy Clusters with PLANCK Results

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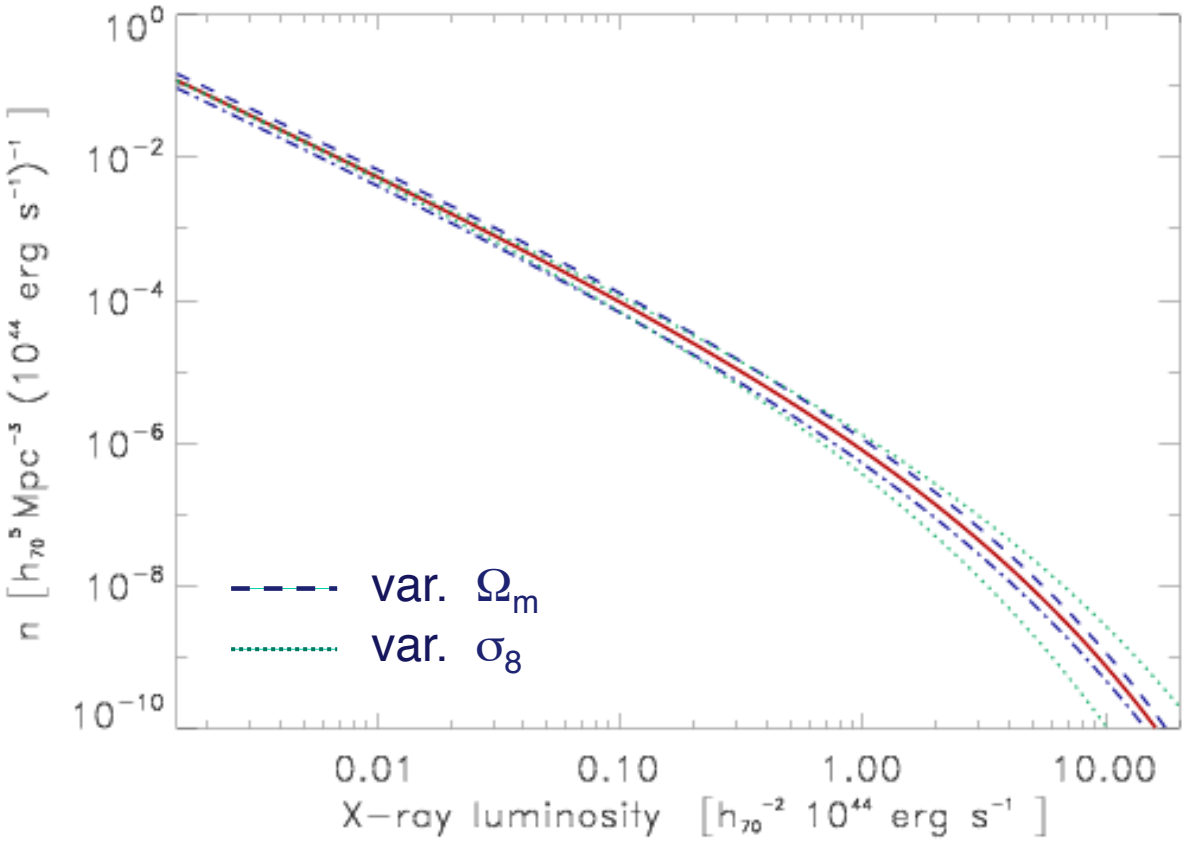
Overview

- **Cosmological constraints from REFLEX**
- **Effect of massive neutrinos**
- **Evidence for a local underdensity**

Predicted Cluster Luminosity Function
with parameter dependence



background cosmology

⇩

structure formation P(k)

⇩

Mass function (Tinker)

⇩

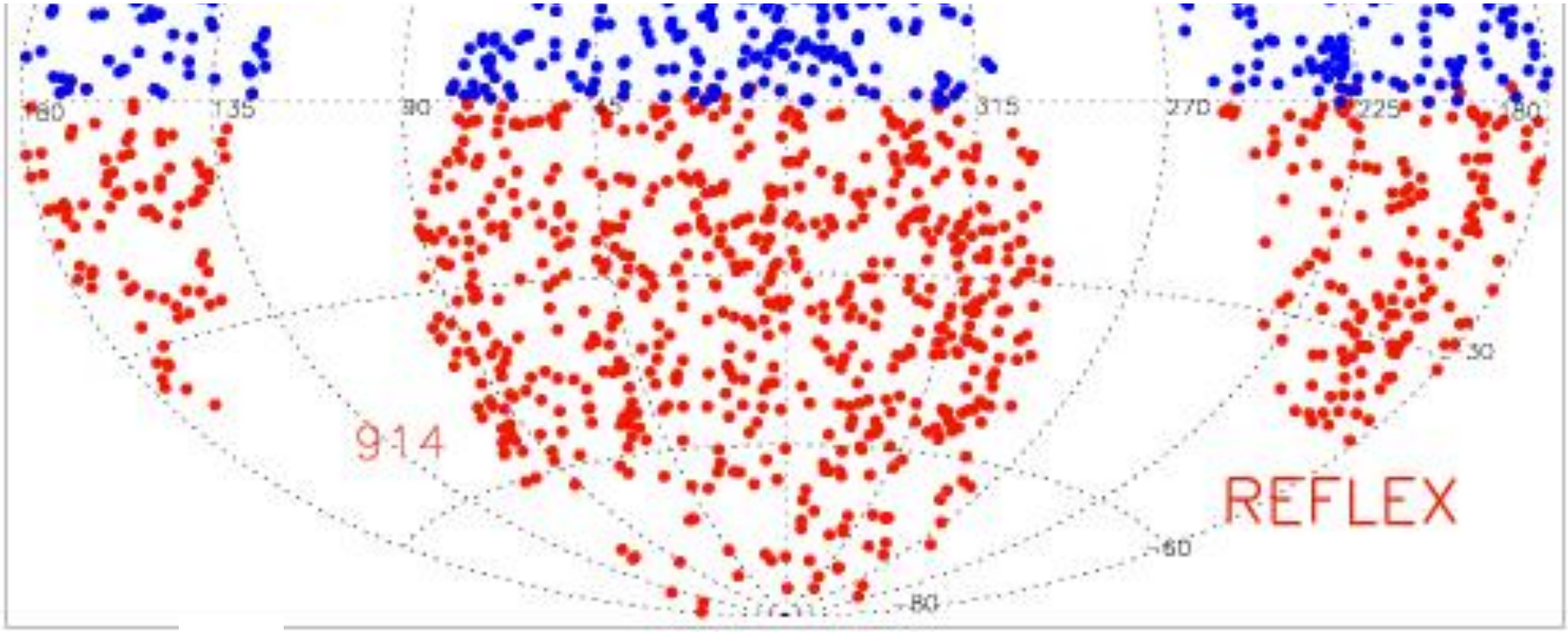
L_X-mass scaling relation

⇩

X-ray luminosity function

Sensitive dependence on σ_8 and Ω_m

The REFLEX Galaxy Cluster Survey



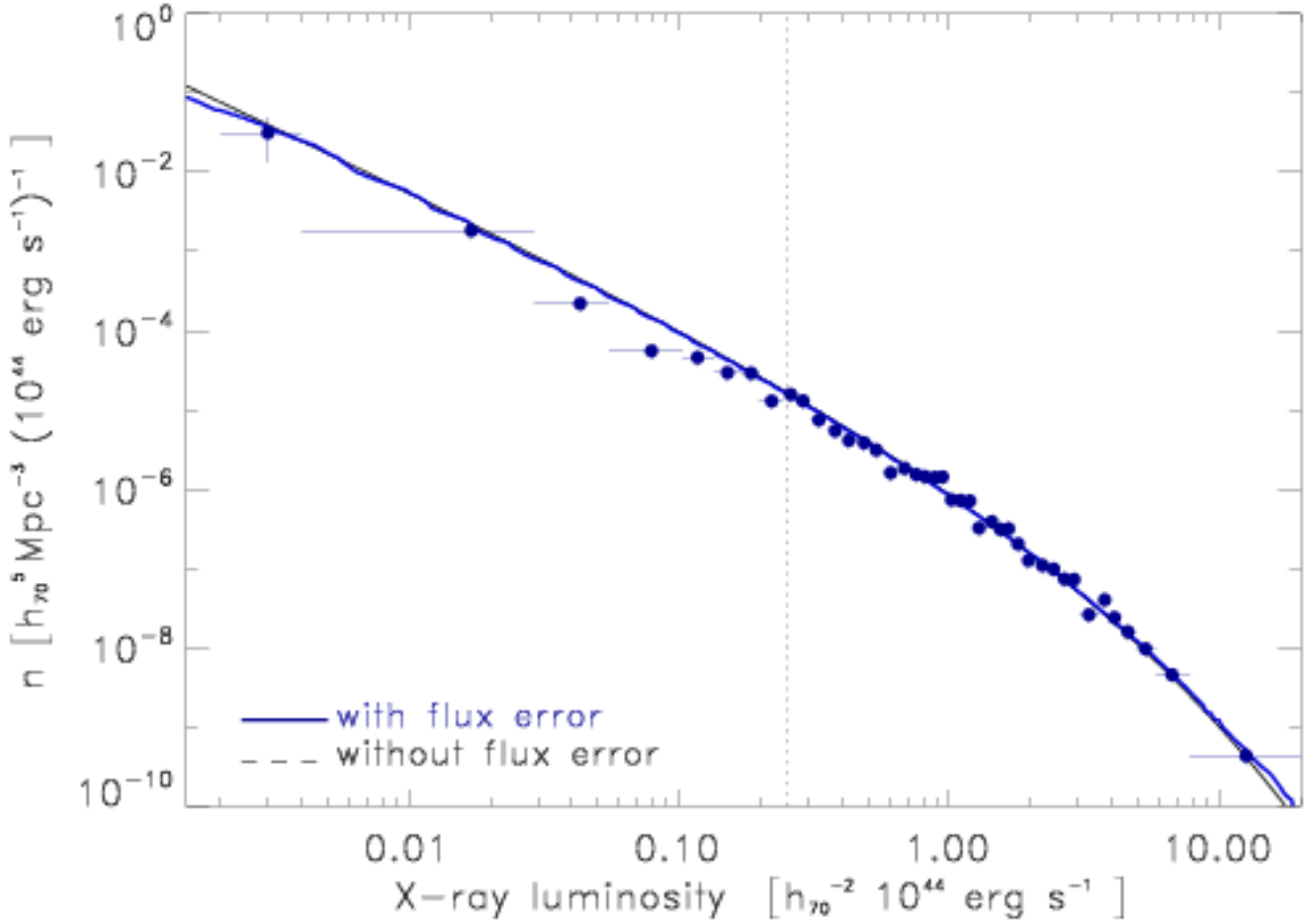
REFLEX II 911 clusters $F_X > 1.8\ 10^{-12}$ erg s^{-1} cm^{-2}

REFLEX I: 18 runs La Silla REFLEX II: 9 runs ESO 3.6m/NTT

Sample descriptions: **Böhringer et al. 2001, 2004, 2013**

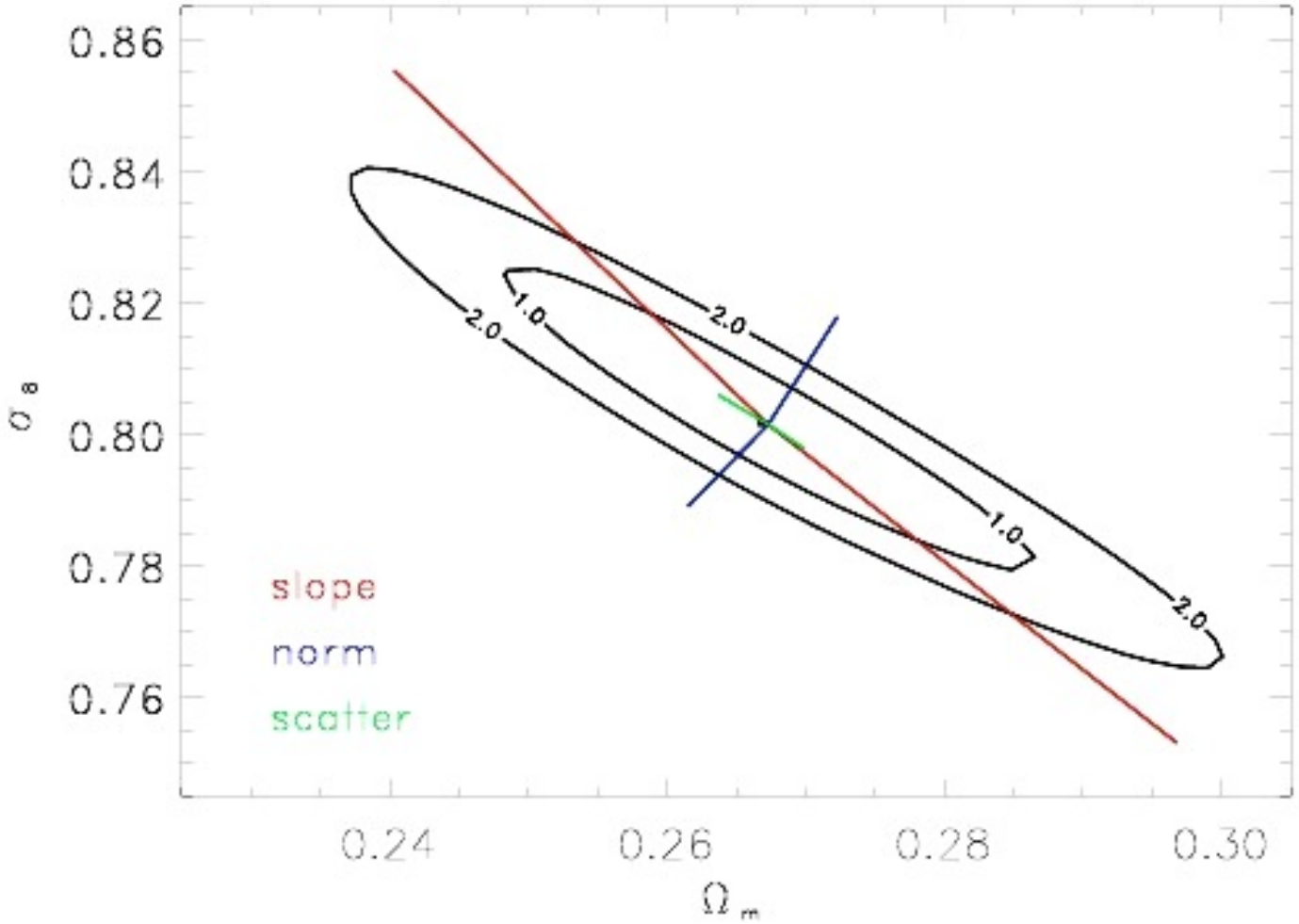
Observed and predicted X-ray luminosity function

Prediction from a flat ΛCMD model $\Omega_m = 0.27$, $\sigma_8 = 0.80$ and REFLEX II XLF



Böhringer et al. 2014

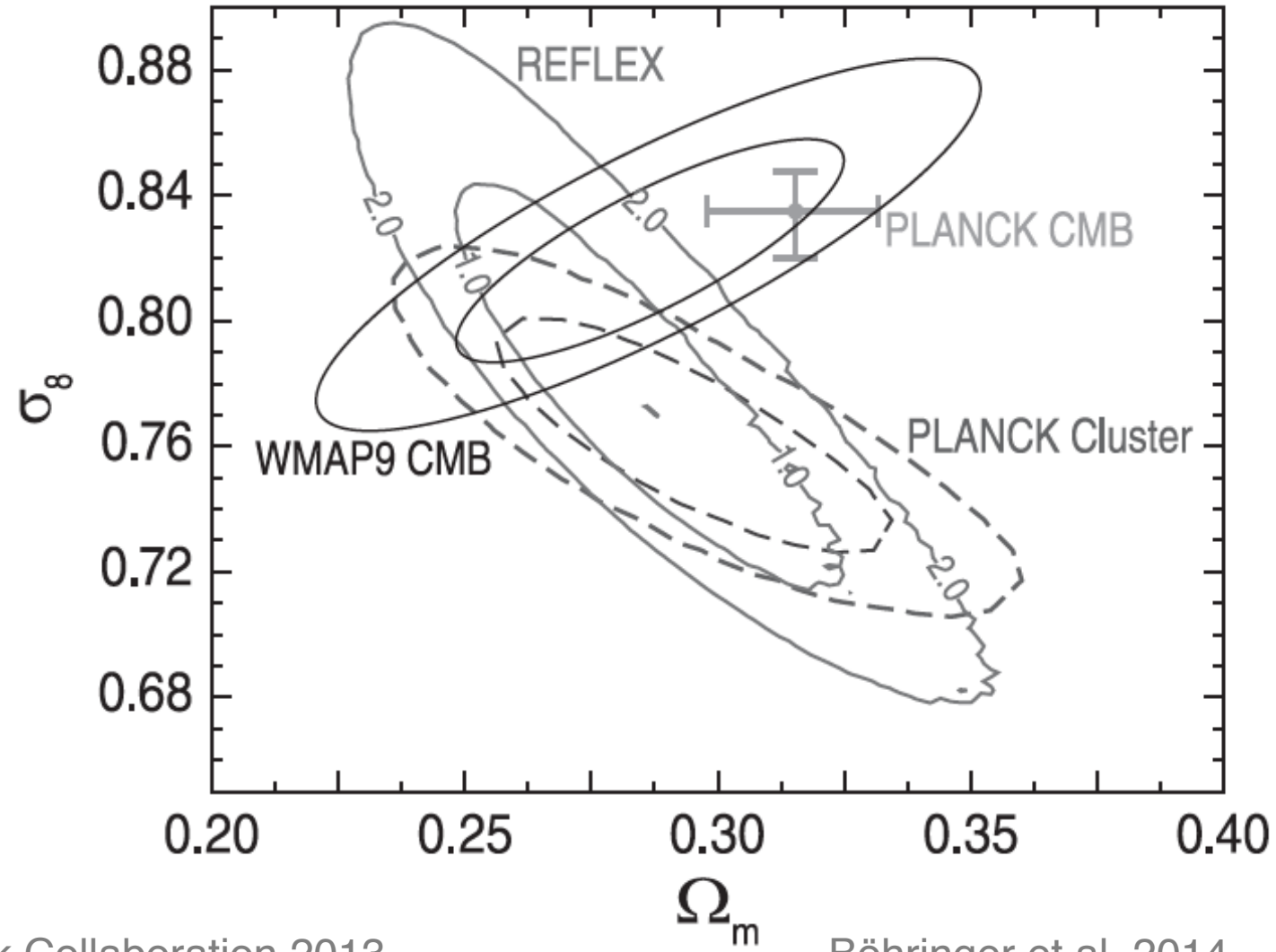
Influence of the scaling relation on the cosmological constraints



slope +- 5%, normalization +- 10%, scatter +- 10%

Böhringer et al. 2014

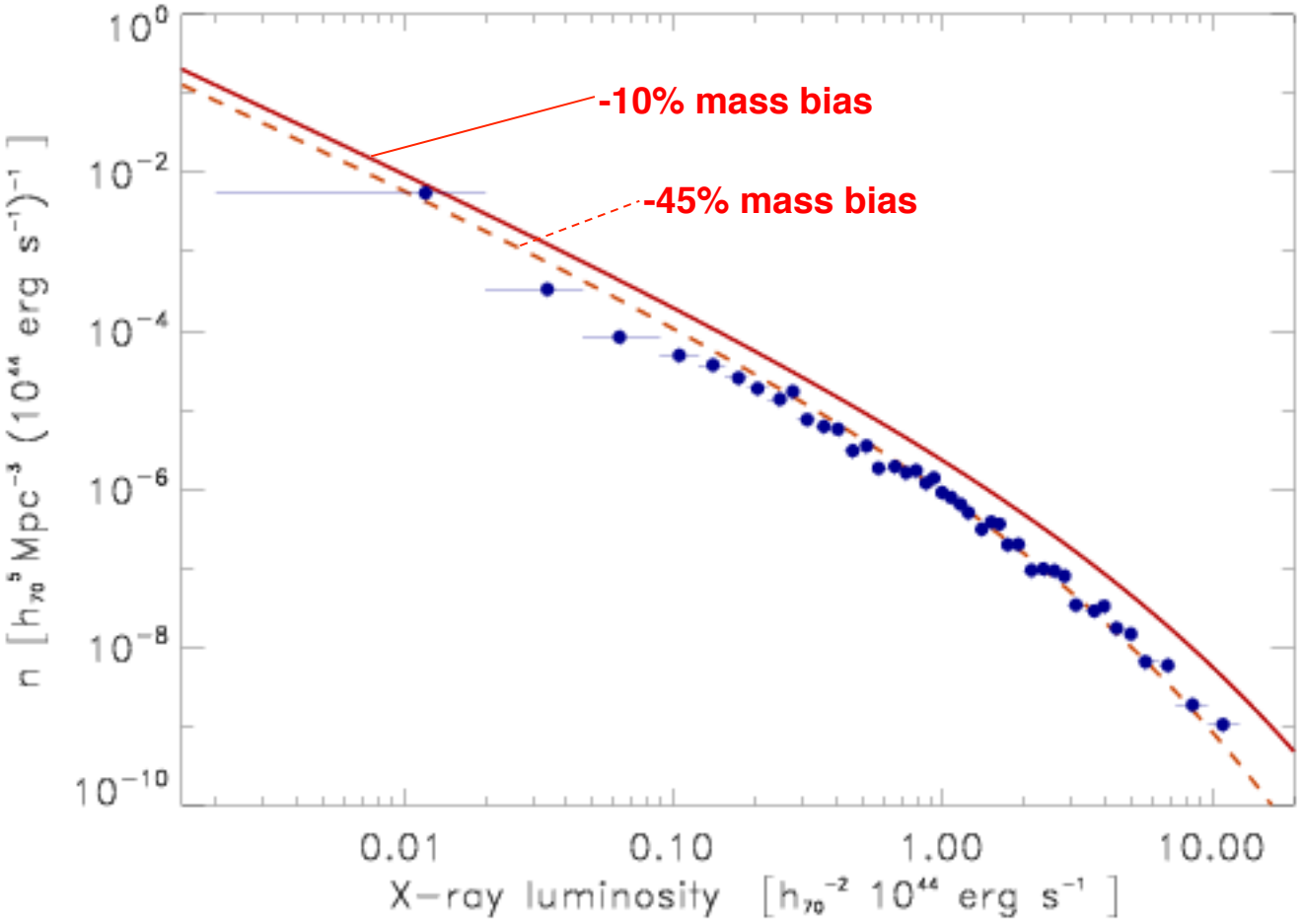
REFLEX and PLANCK cluster and PLANCK and WMAP CMB constraints



Planck Collaboration 2013
Hinshaw et al. 2013

Böhringer et al. 2014

Prediction for PLANCK CMB cosmology

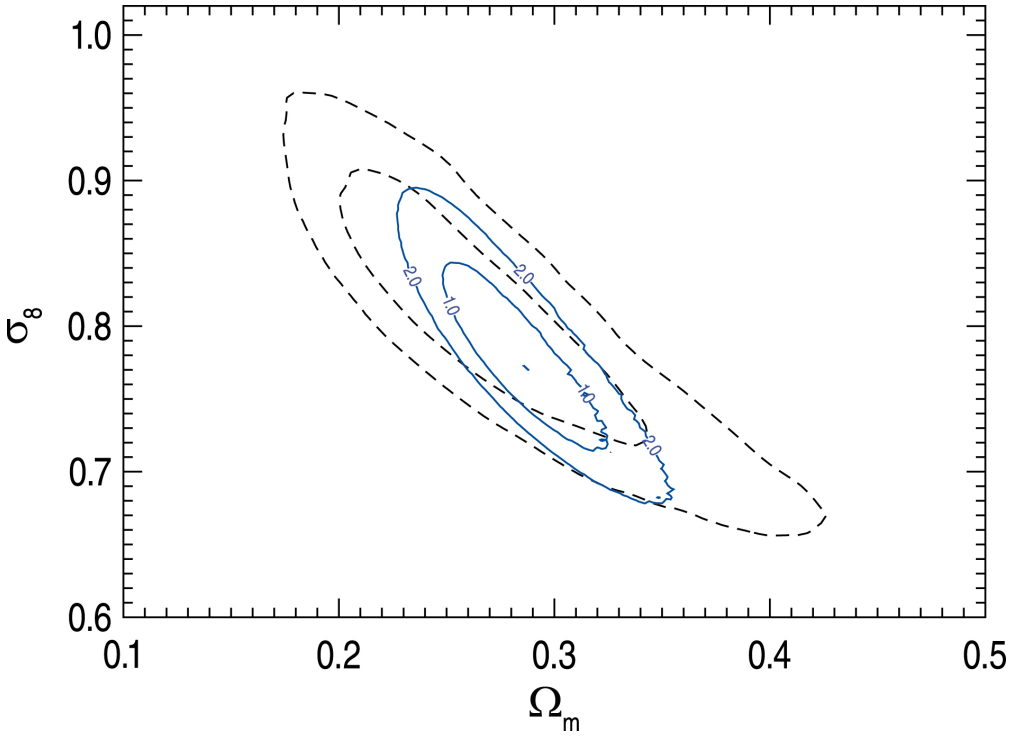


Böhringer et al. 2014

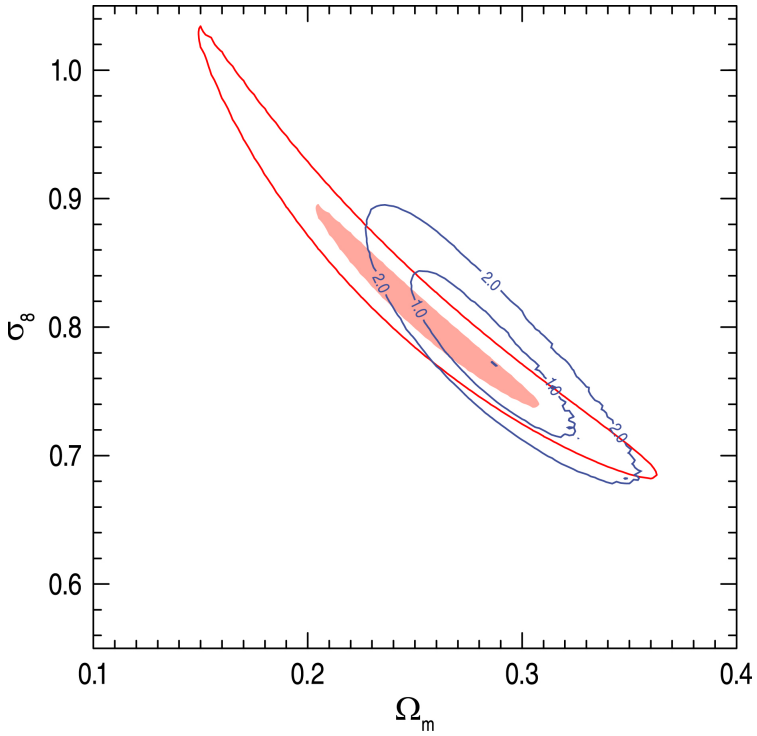
Results from REFLEX II, the SDSS MaxBCG sample and from the 400 deg² survey

Rozo et al. 2010

REFLEX II

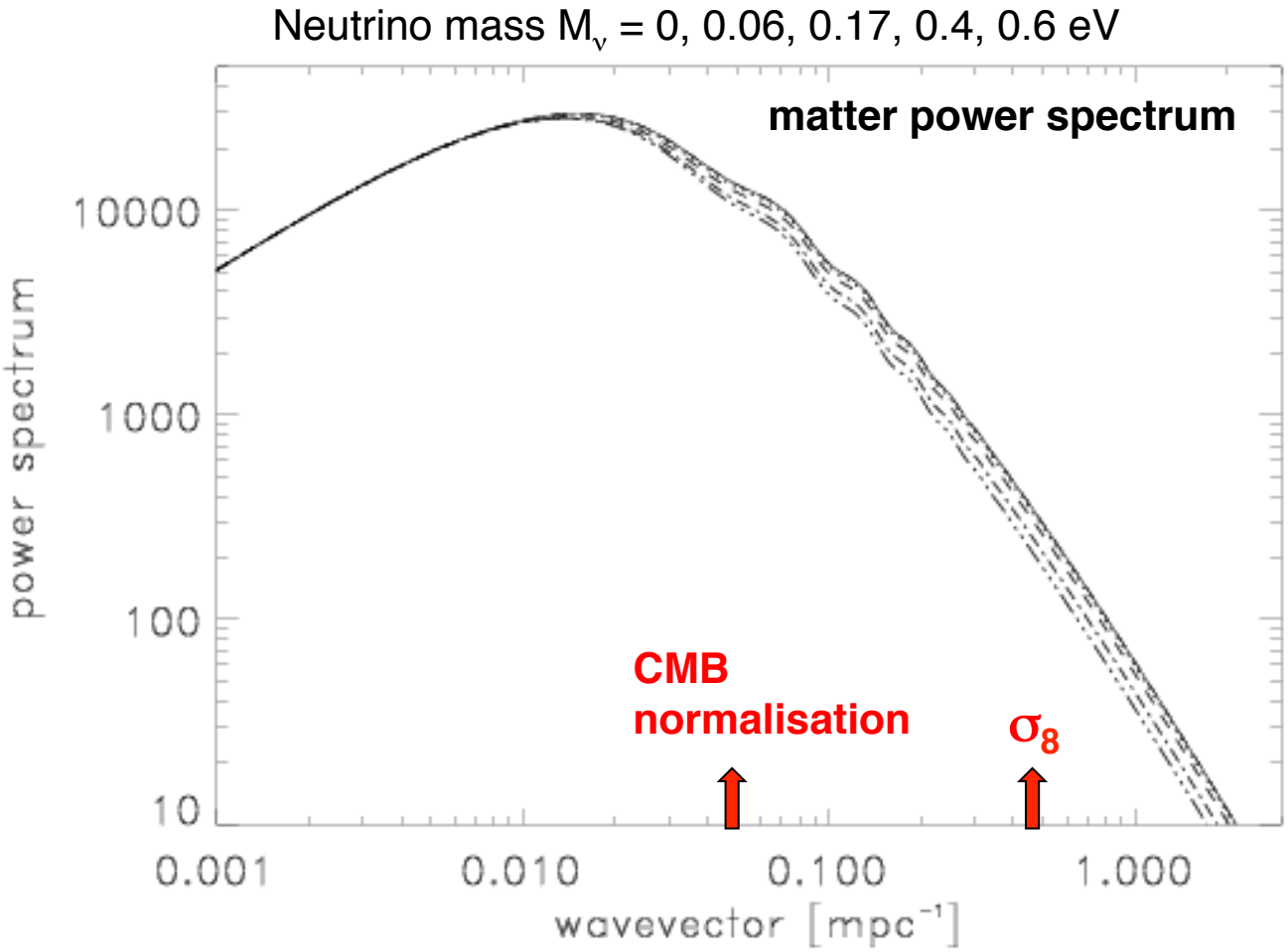


Vikhlinin et al. 2009
local sample: 49 clusters
at <z> = 0.05



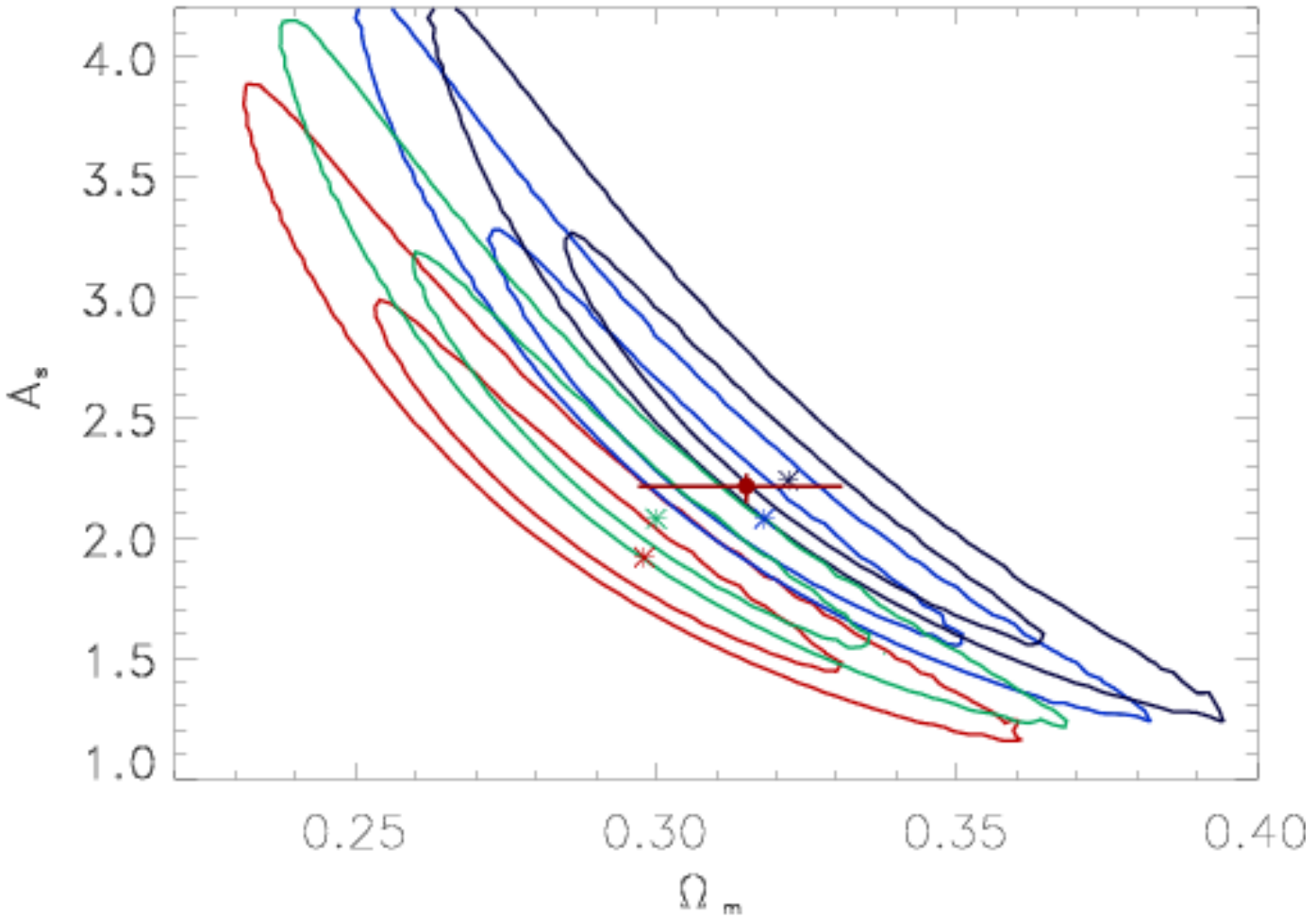
Effect of massive neutrinos

The effect of massive neutrinos



Böhringer et al. 2014, to be submitted

Constraints on A_s and Ω_m for M_ν = 0, 0.17, 0.4, 0.6 eV

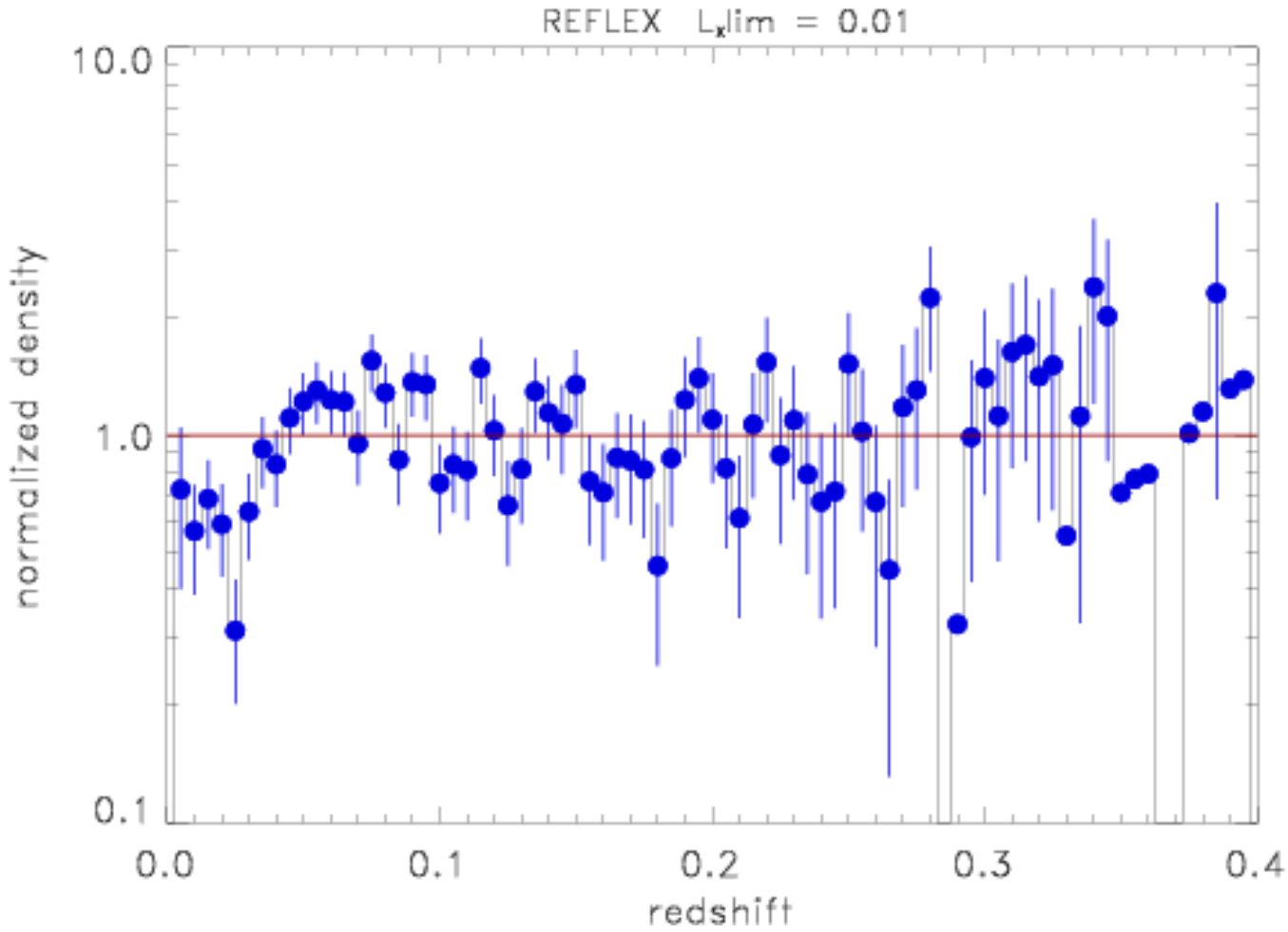


Formal consistency for M_ν = 0.45 +- 0.2 eV

Böhringer & Chon 2014, A&A, submitted

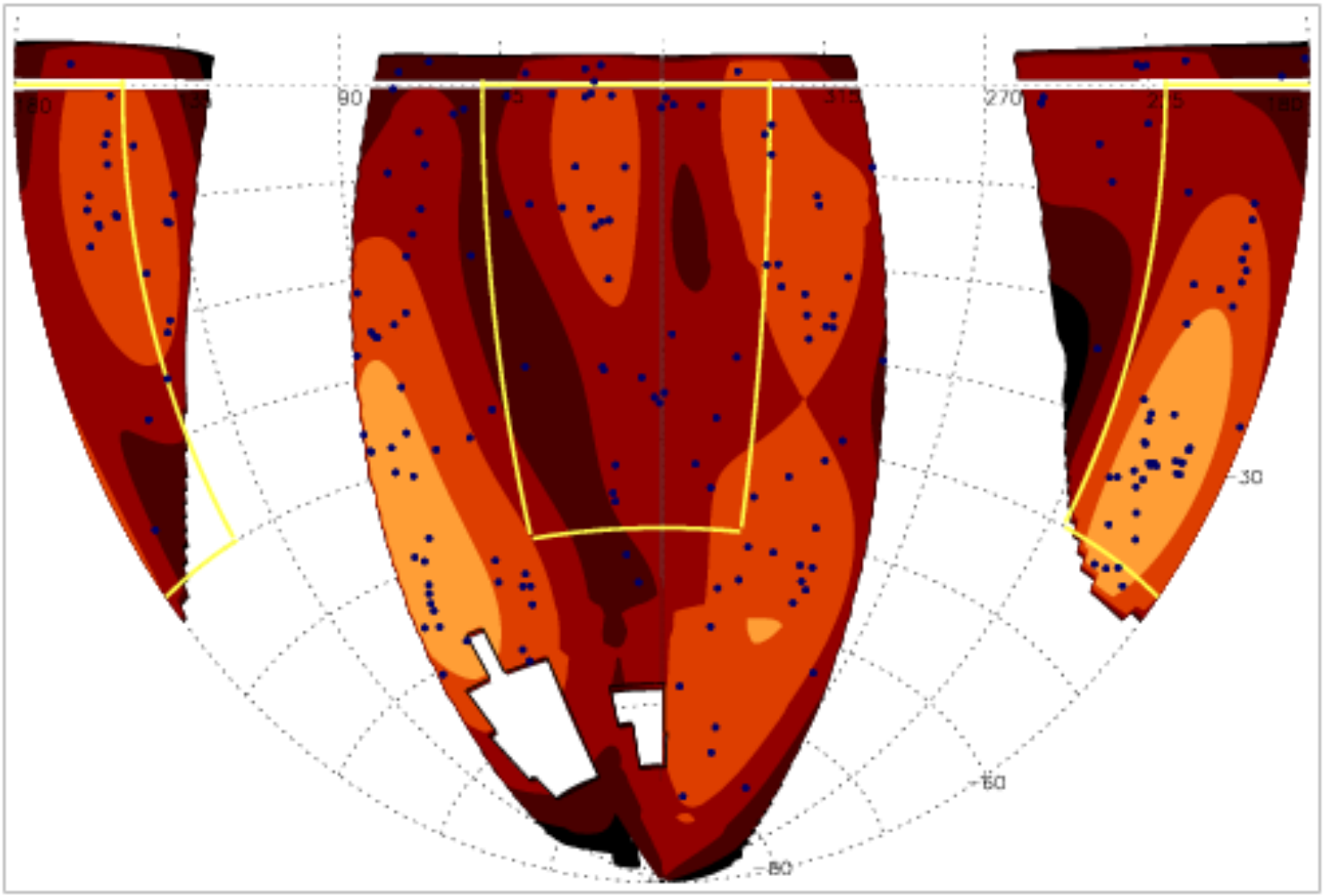
Local Cosmography

REFLEX Cluster Density Distribution as Function of Redshift



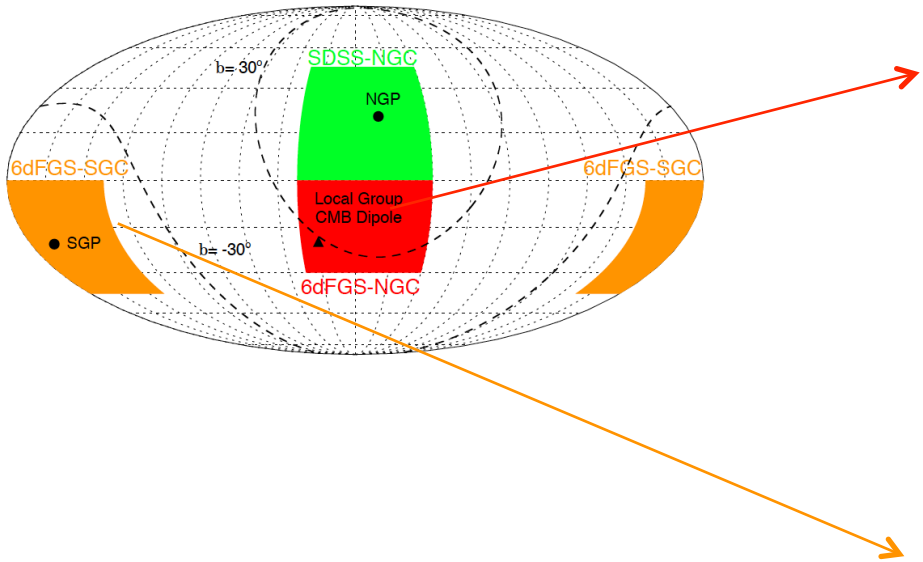
Böhringer et al. 2014

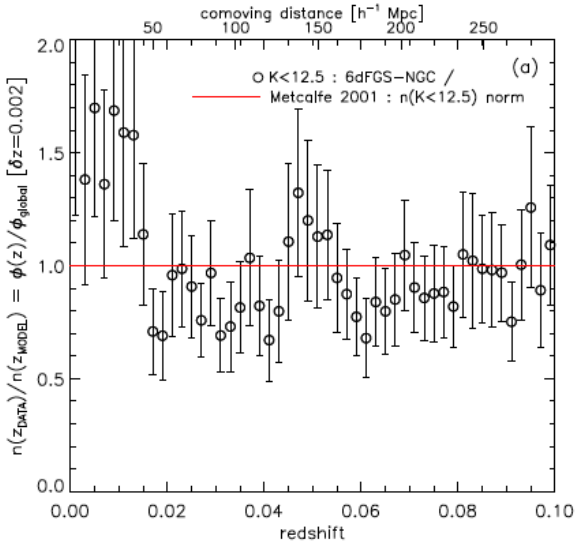
REFLEX Cluster Density Distribution at $z < 0.06$

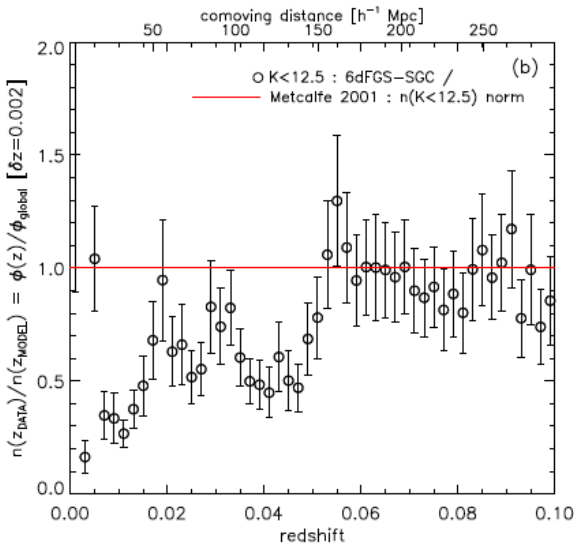


Böhringer et al 2014

Local Underdensity in the Galaxy Distribution in the South Galactic Cap







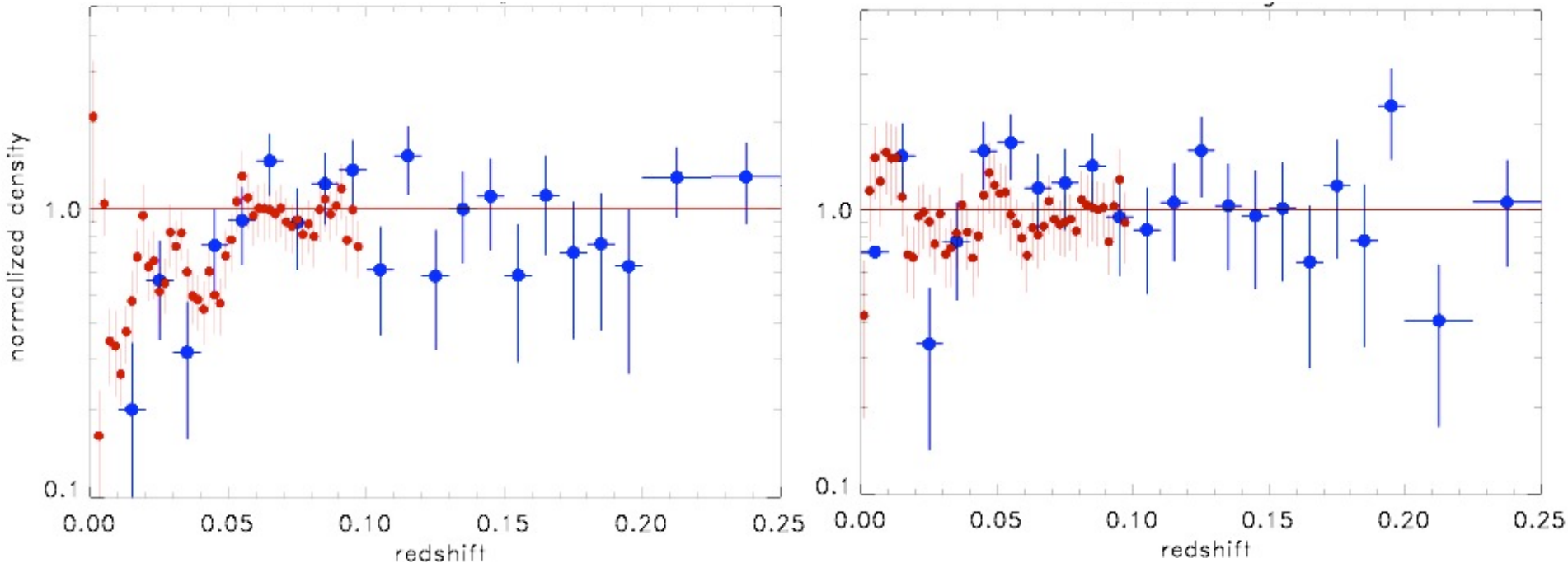
Whitbourn & Shanks 2014

(see also Keenan et l. 2012)

REFLEX Cluster Density Distribution in the North and South Galactic Cap (in the Southern Sky)

South galactic cap region

North galactic cap region in South



Böhringer et al. 2014

Conclusions

- Cosmological constraints on σ_8 and Ω_m from REFLEX, best local cluster sample, disagrees with PLANCK CMB within standard ΛCMD framework

Unlikely solutions:

- Clusters need to be heavier by factor ~2 than we assume

- Neutrino masses add up to 0.45+- 0.2 eV

- Clusters allow cosmographical studies of matter density distribution → local void region in the south galactic cap (size ~ 170 Mpc)