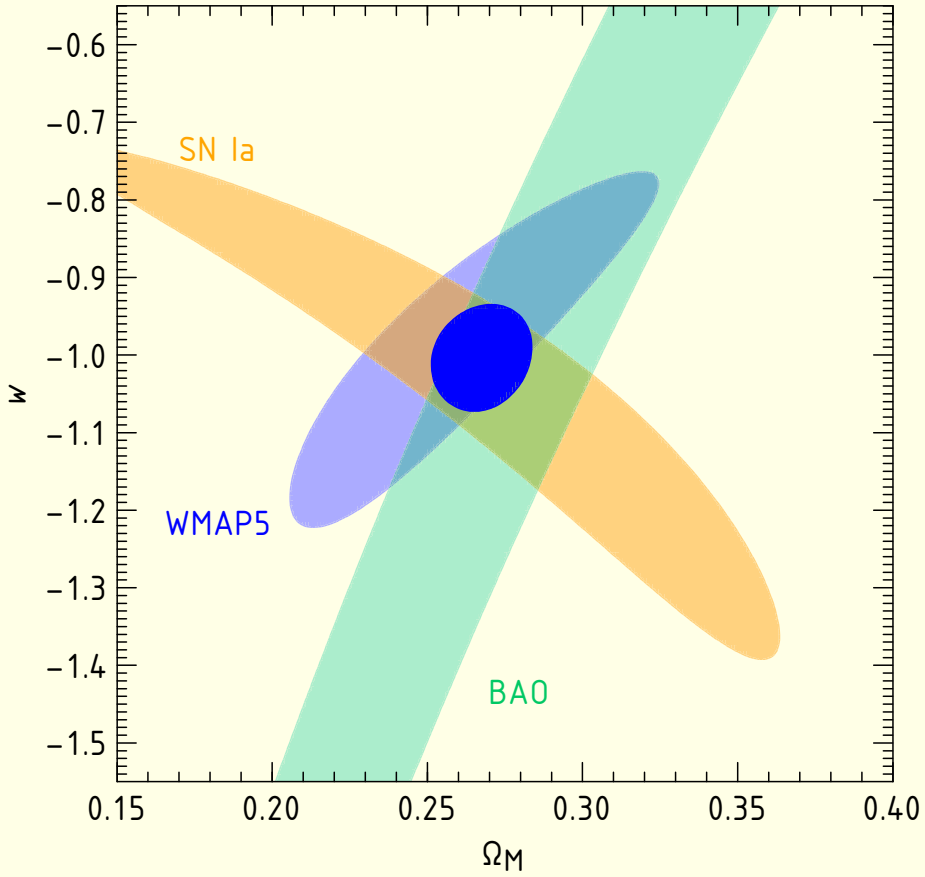
Dark energy with cluster $n(M,z)$



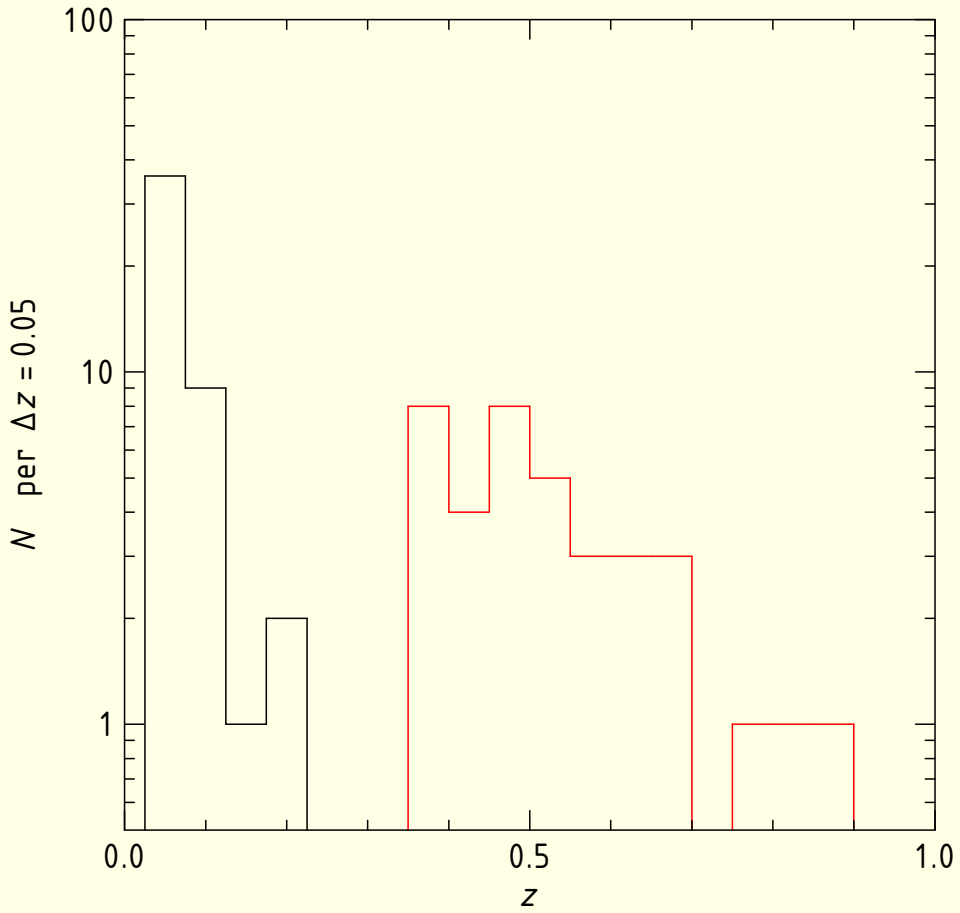
results from 400d survey

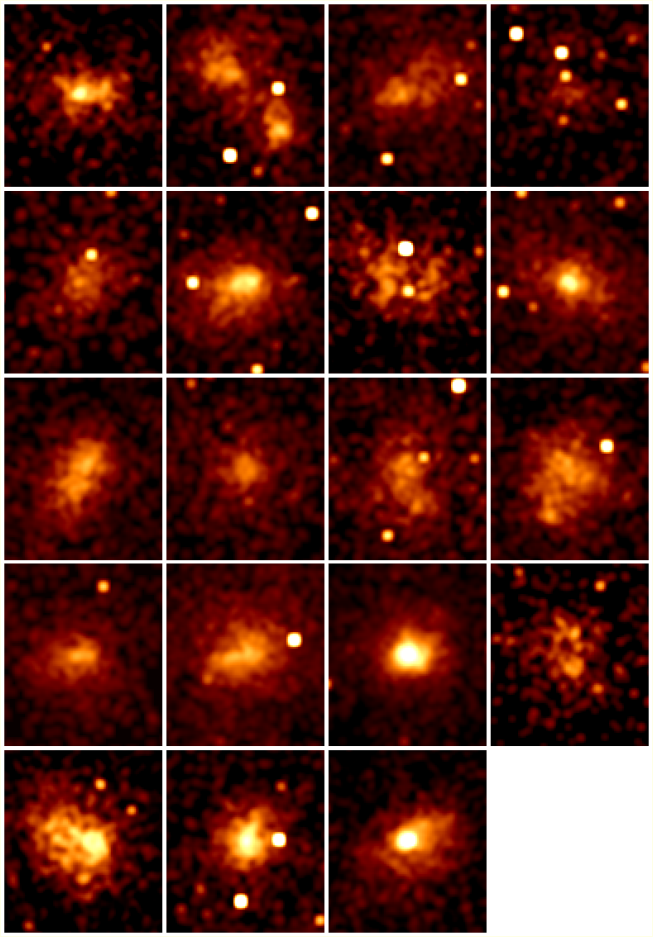
A. Vikhlinin, A. Kravtsov, R. Burenin, H. Ebeling, W. Forman, A. Hornstrup

C. Jones, S. S. Murray, D. Nagai, H. Quintana, A. Voevodkin

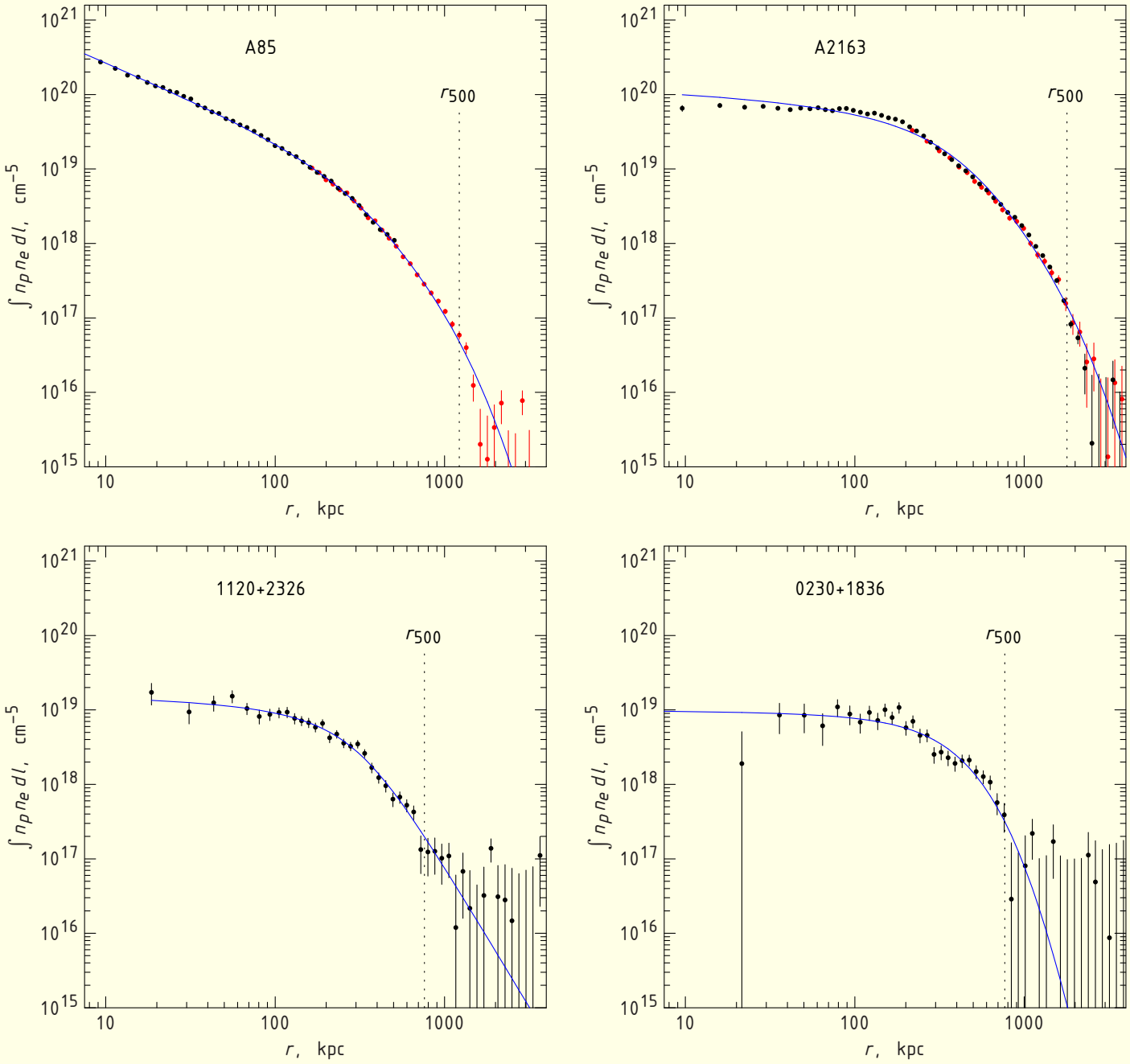
Cluster samples

- Parent X-ray surveys yield 100's of clusters
- *Chandra* Cluster Cosmology Project
  - 36 at $z > 0.35$ from 400d `http://hea-www.harvard.edu/400d`
  - 48 at $z \sim 0.05 - 0.15$ from ROSAT All-Sky Survey (*Chandra* archive)

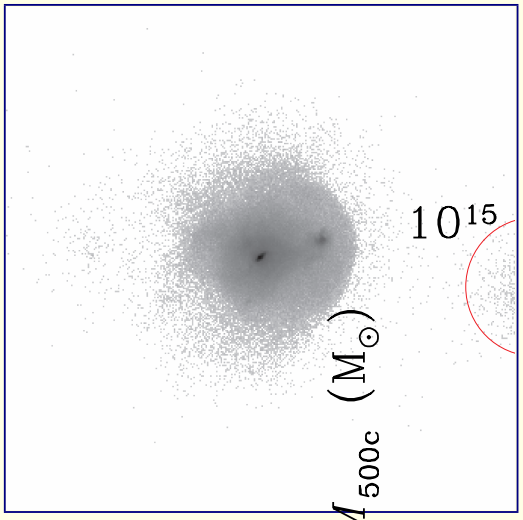


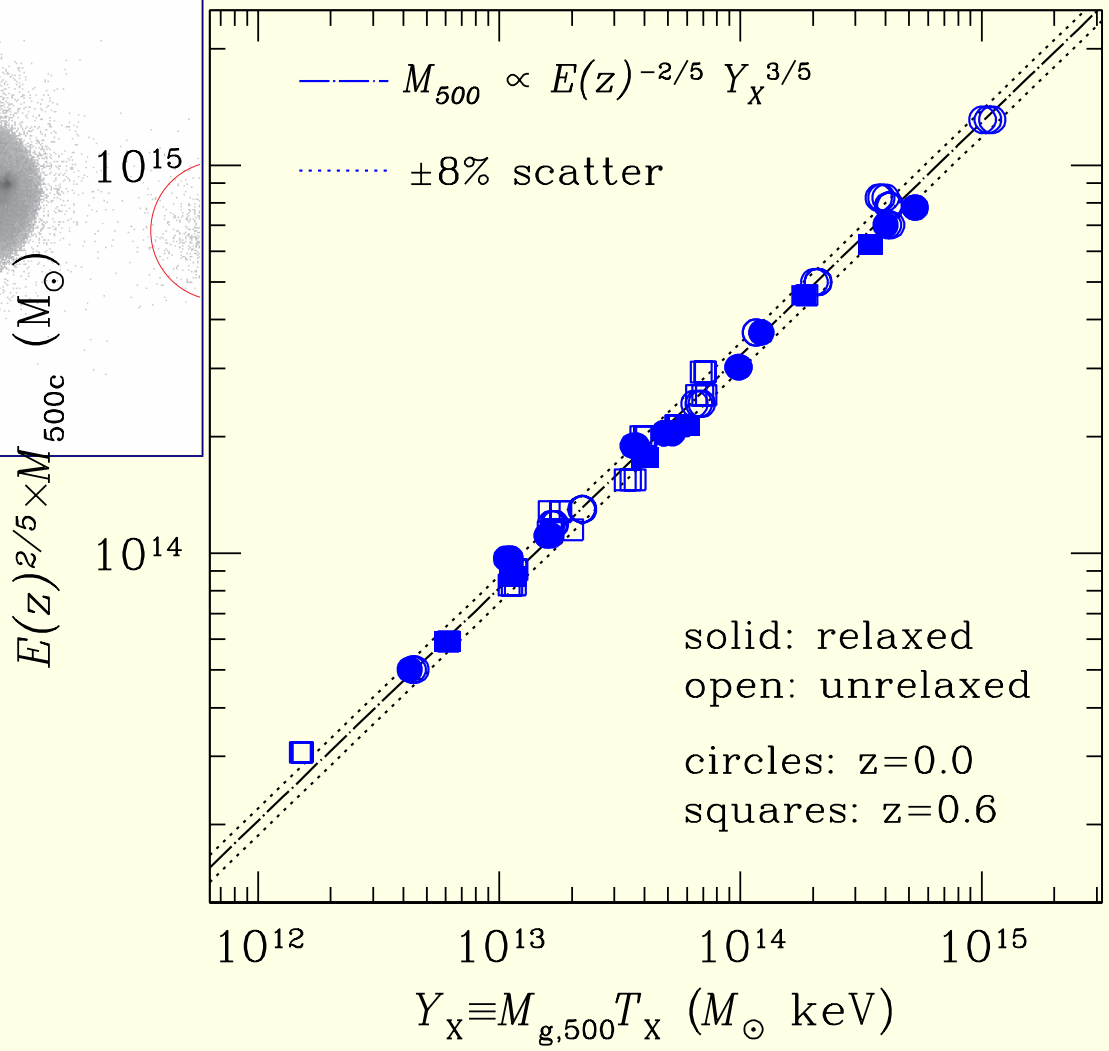


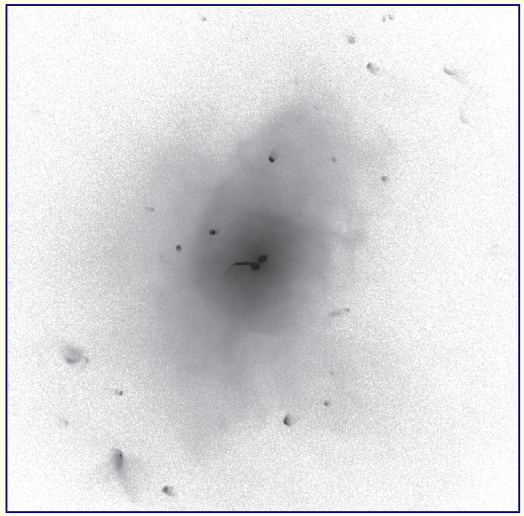
Data quality



Simulations say, use $Y_X = T_X \times M_{gas}$



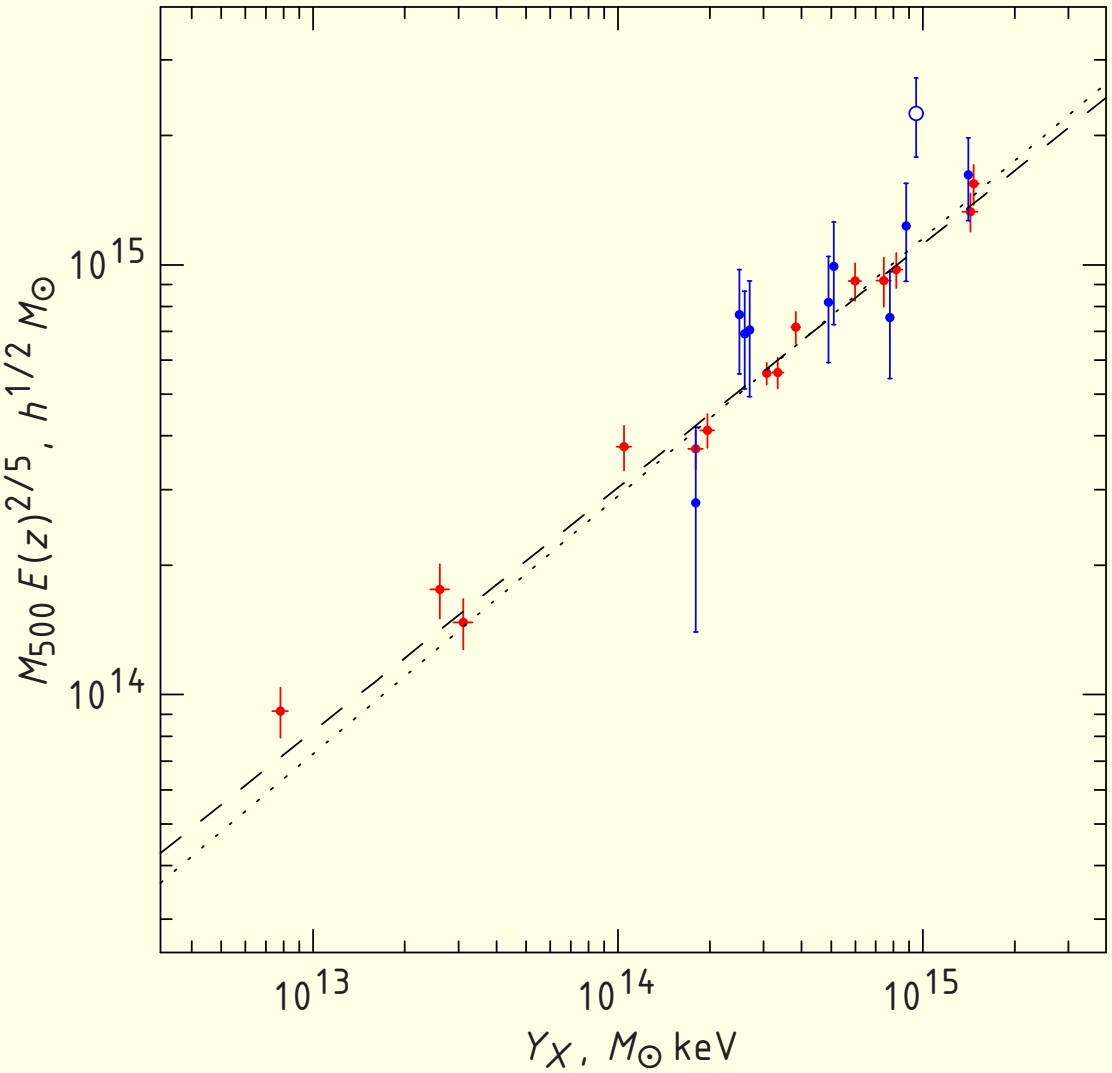




- $M \propto Y_X^{3/5}\, E(z)^{-2/5}$ — follows from self-similarity + virial theorem + "fair sample"

papers by Kravtsov, Nagai & AV

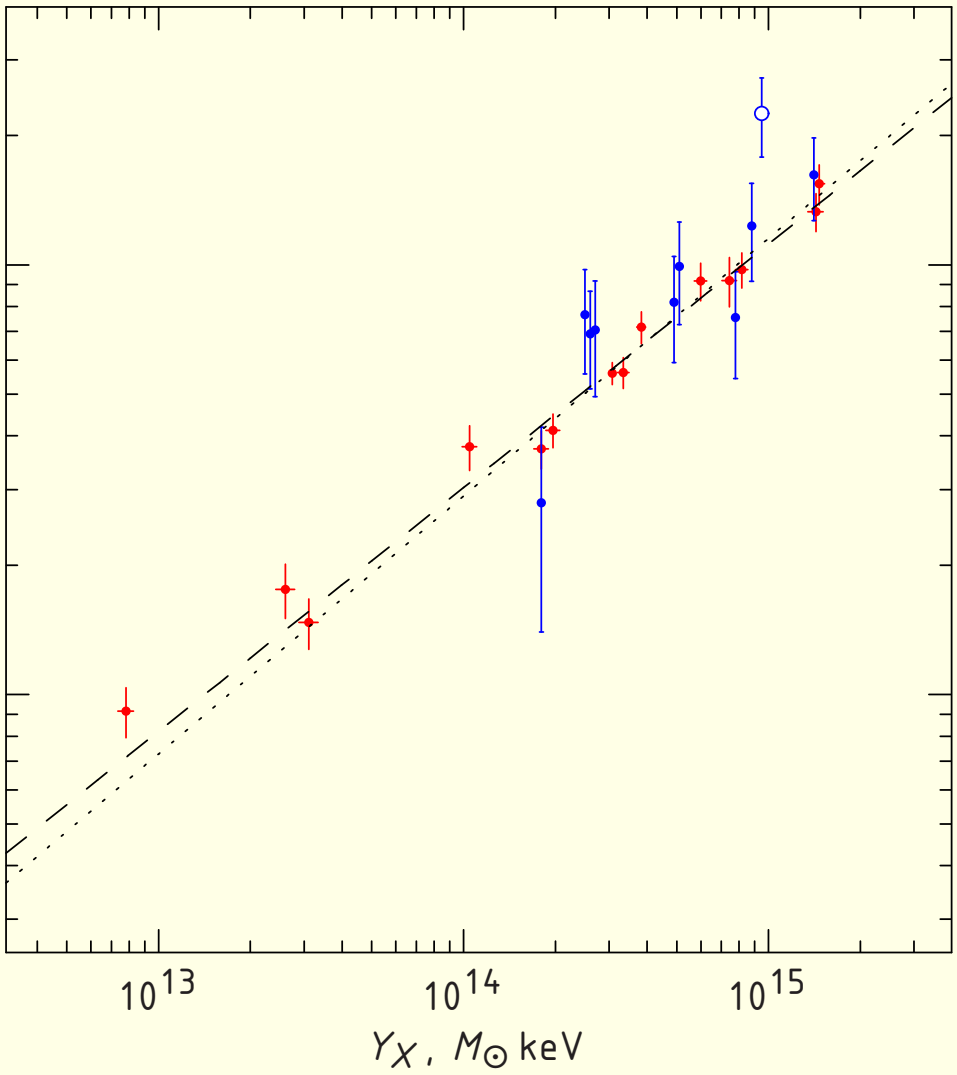
Calibration of M_{tot}



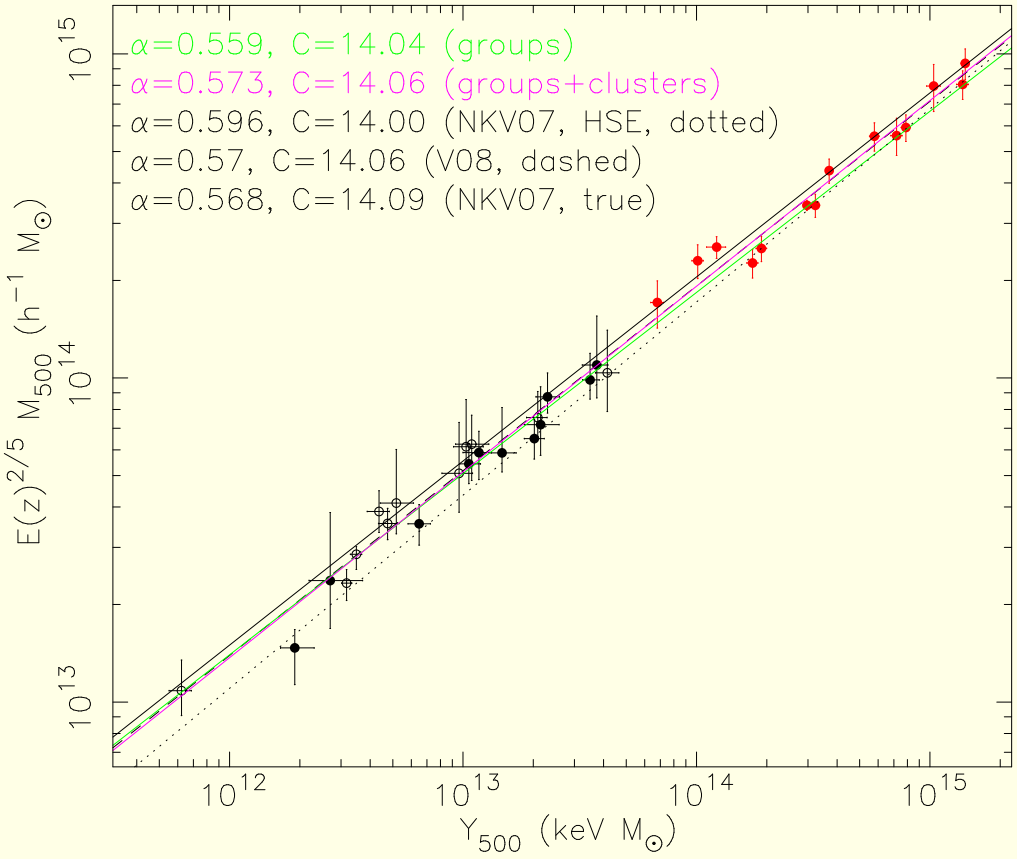
• — ***Chandra*, hydrostatic;** • — **weak lensing, Hoekstra '07**

Systematic errors: $\Delta M/M < 9\%$ at $z = 0$ $\qquad \Delta \dfrac{M(z=0.5)}{M(z=0)} < 5\%$

Calibration of M_{tot}



Fits also groups! M.Sun et al. '08



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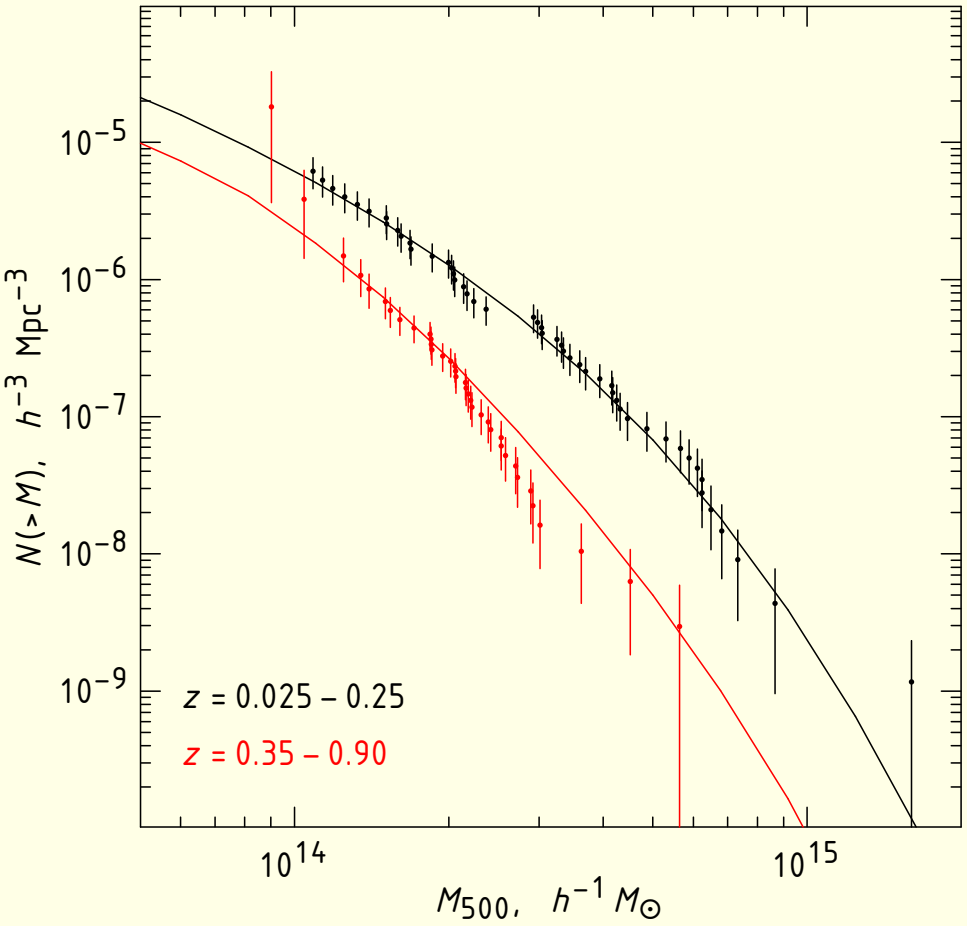
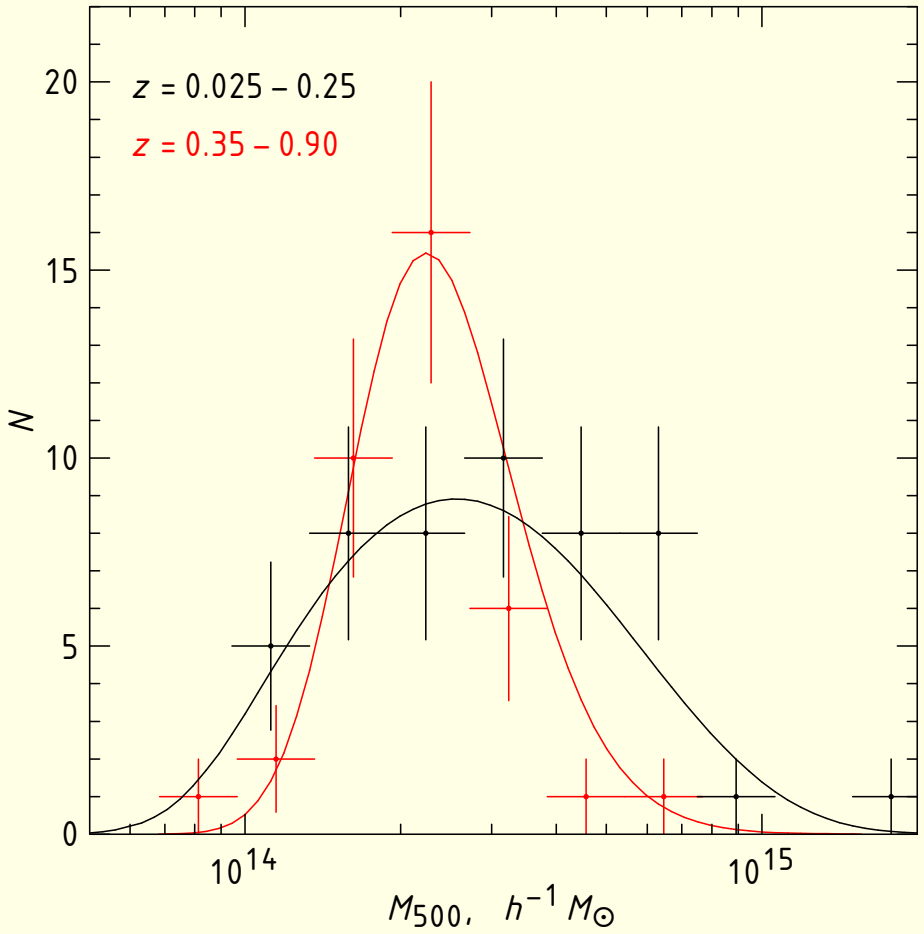
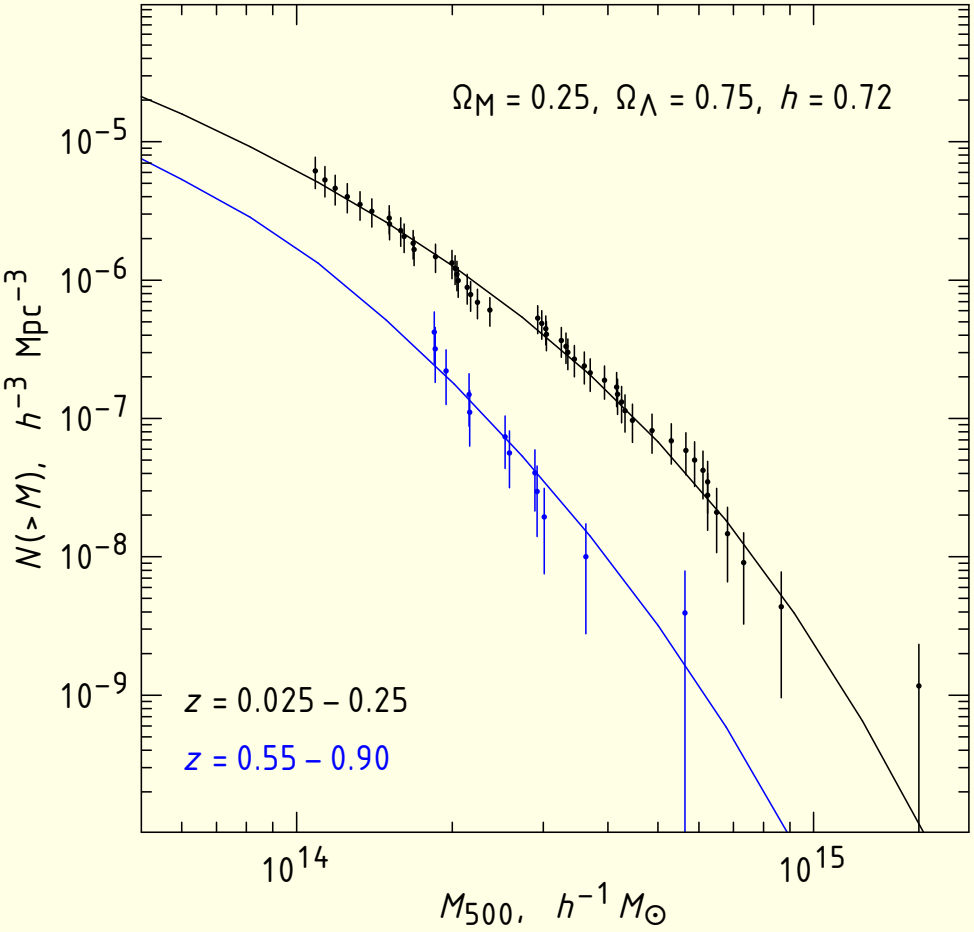
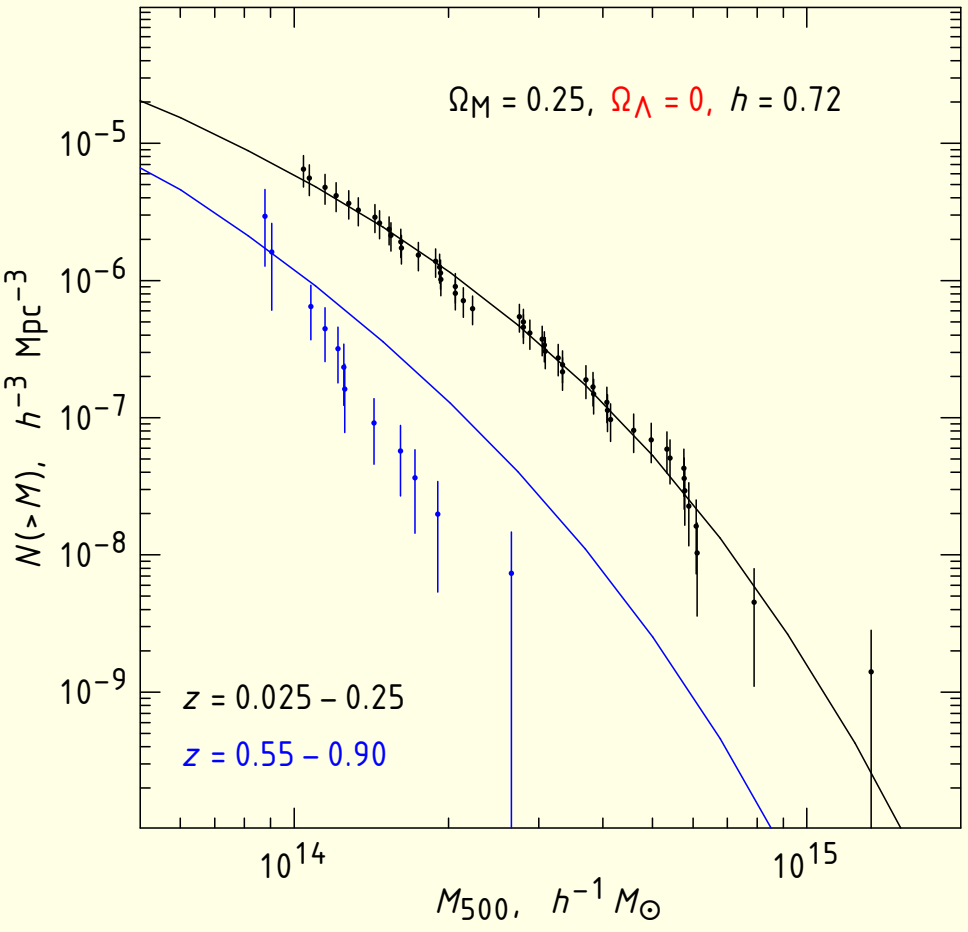
Mass function data



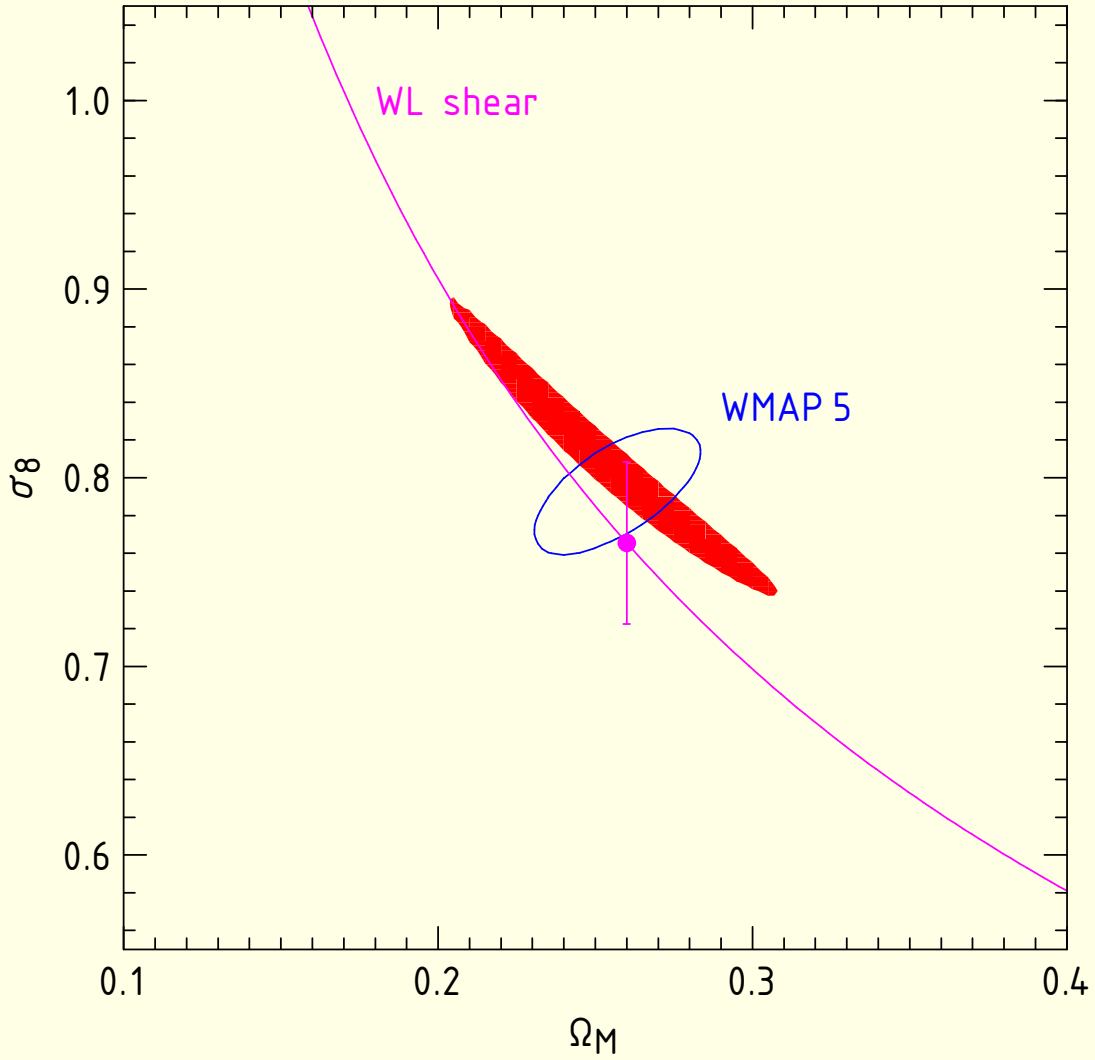


Detection of Λ



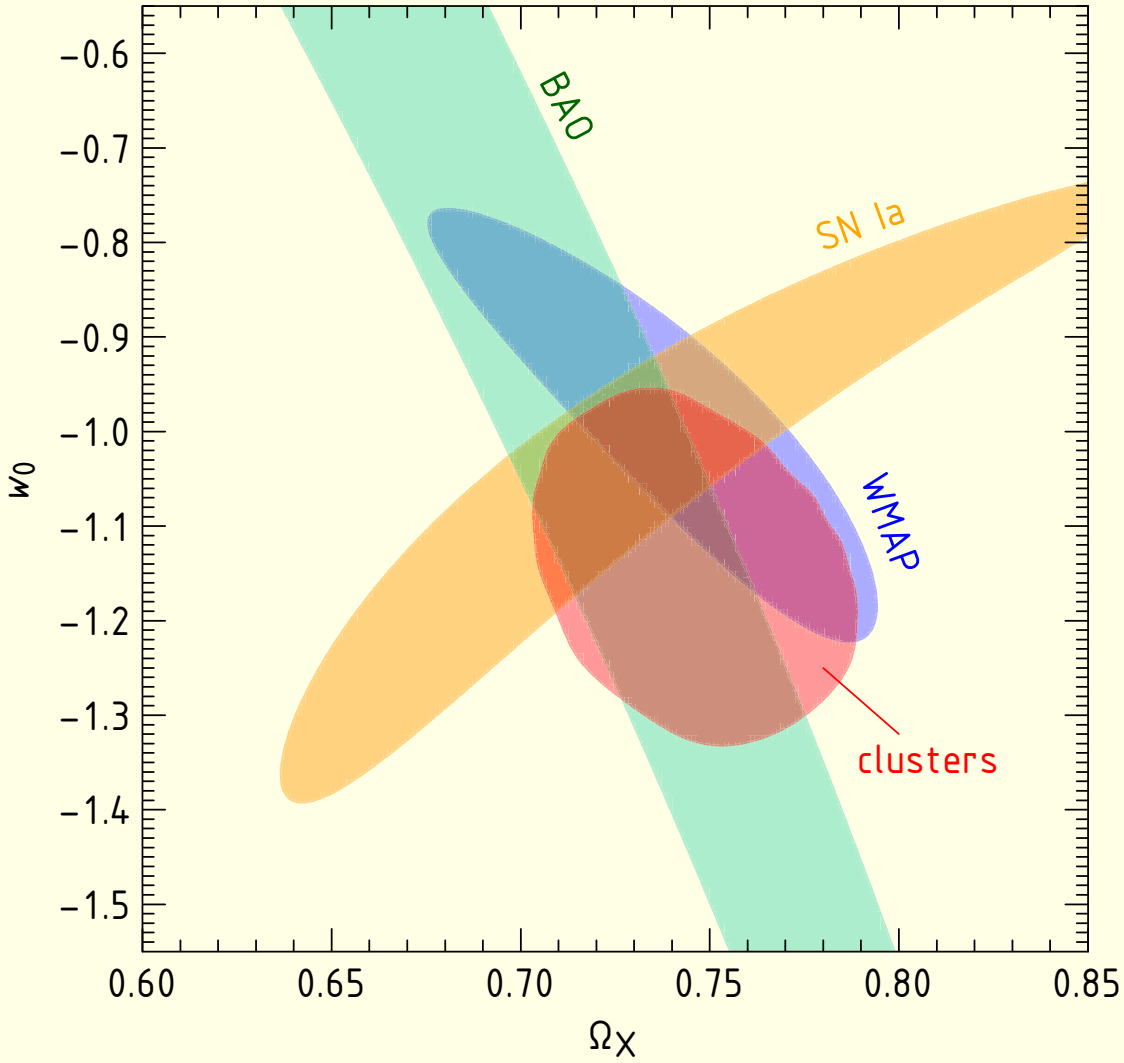


σ_8



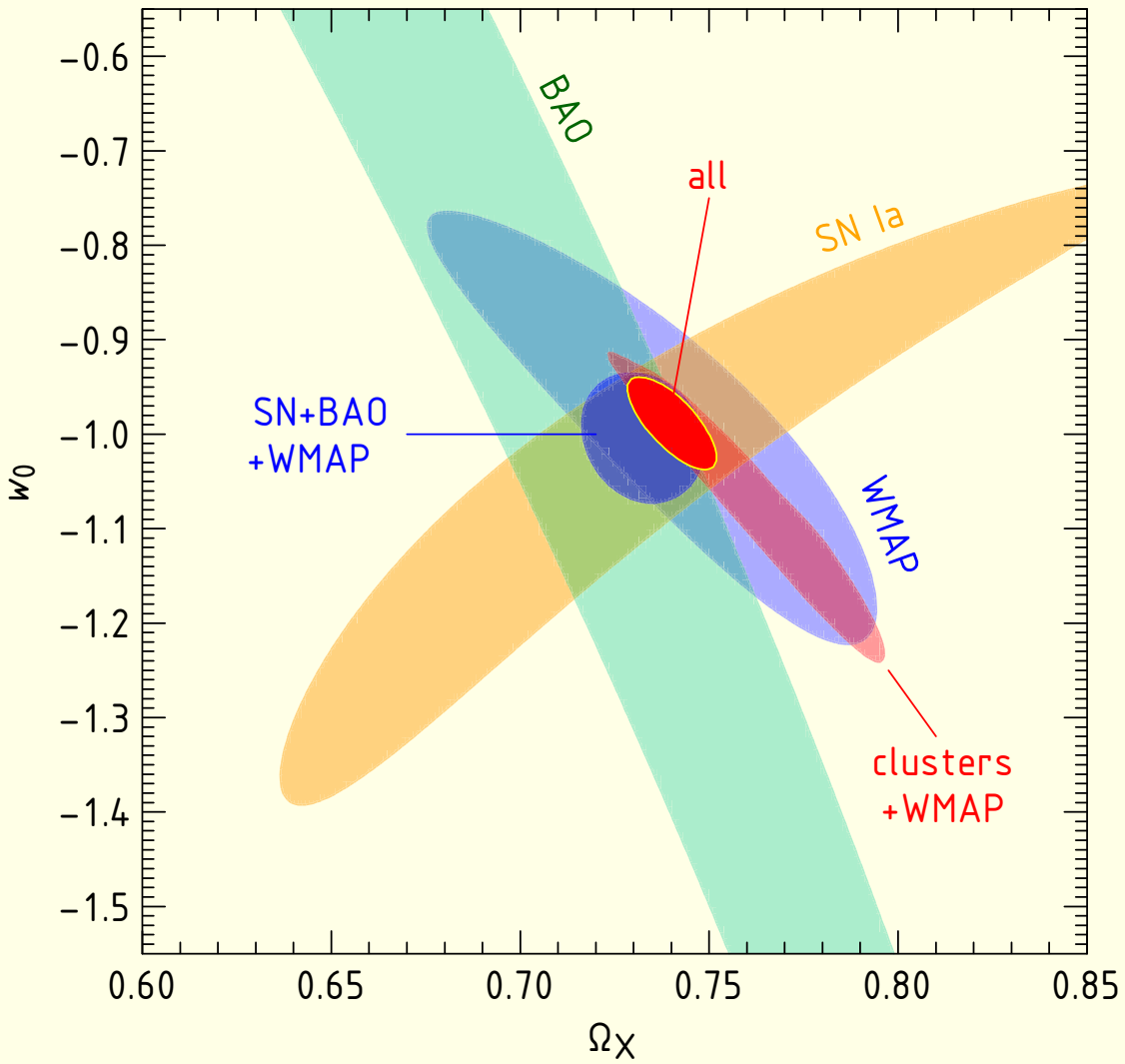
For $\Omega_M = 0.25$: $\sigma_8 = 0.813 \quad \pm 0.013\ (\text{stat}) \quad \pm 0.024\ (\text{sys})$

Equation of state constraints



$w_0 = -1.14 \quad \pm 0.21\ (\text{stat}) \quad \pm 0.13\ (\text{sys})$

w_0 constraints: CMB + SN + BAO + clusters



- $w_0 = -0.99 \pm 0.045$ (stat) compare with 0.067 without clusters
- More stable to systematics:

  $\Delta w = 0.076$ (SN) $\longrightarrow$ $\Delta w = 0.039$ (0.022 from SN and 0.033 from clusters)

Look for *Chandra* Cluster Cosmology Project papers on astro-ph