What is interesting?

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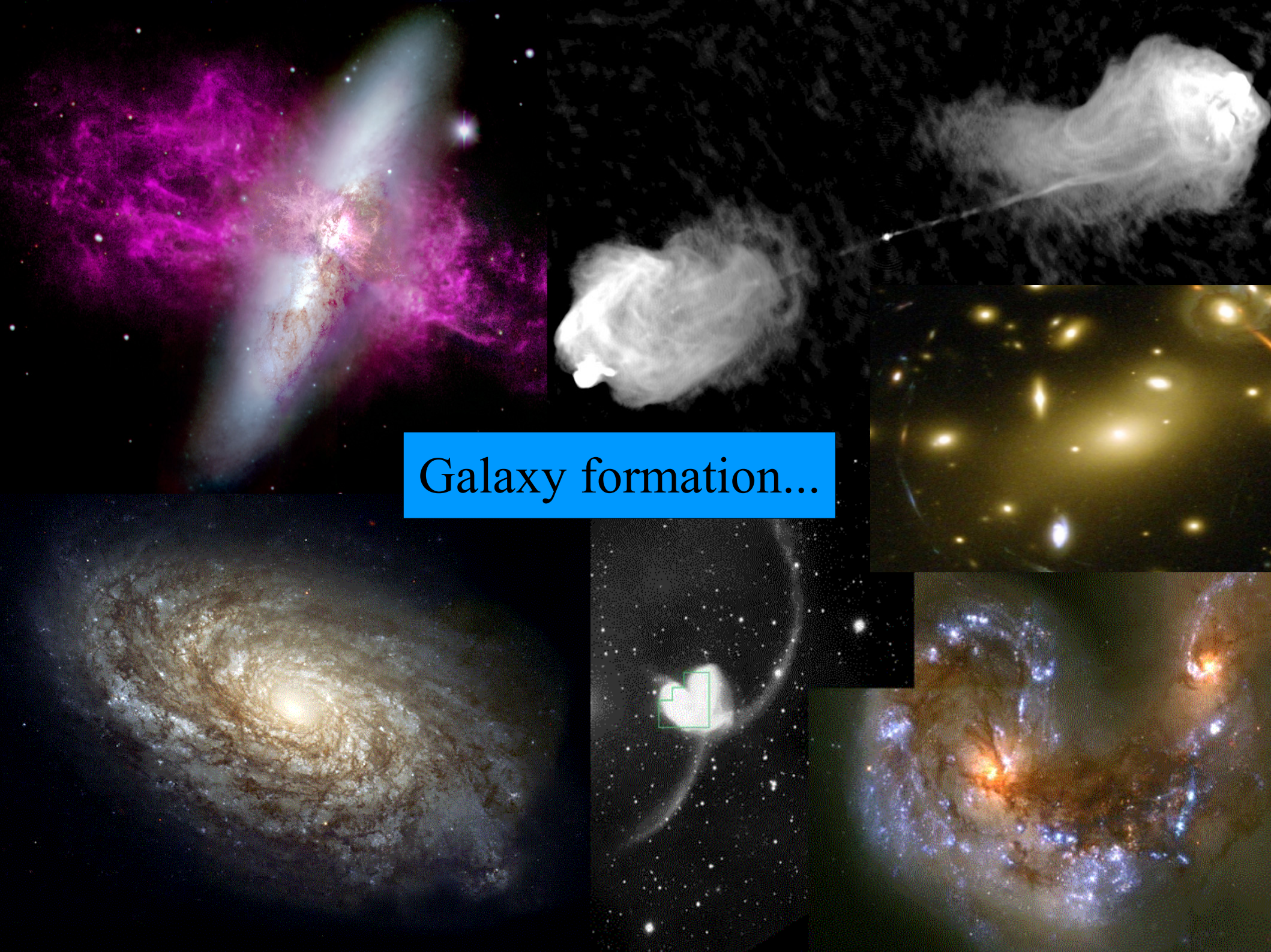
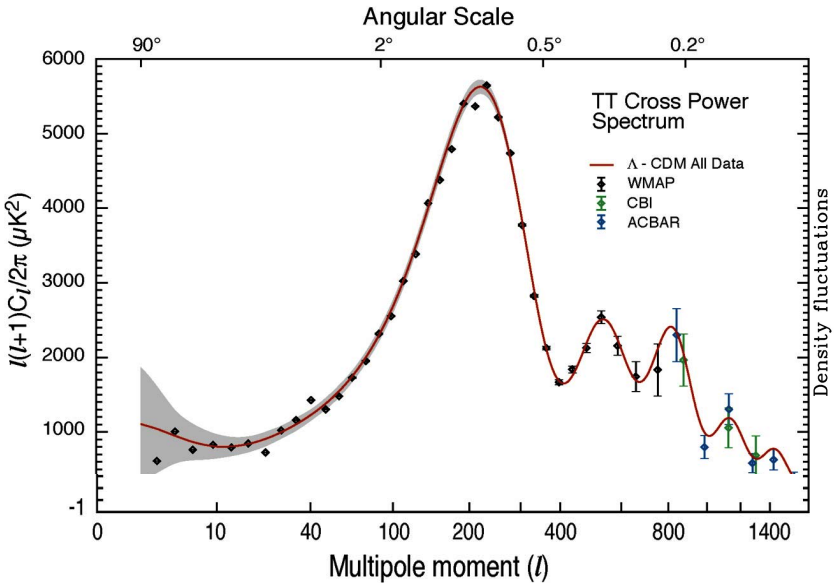
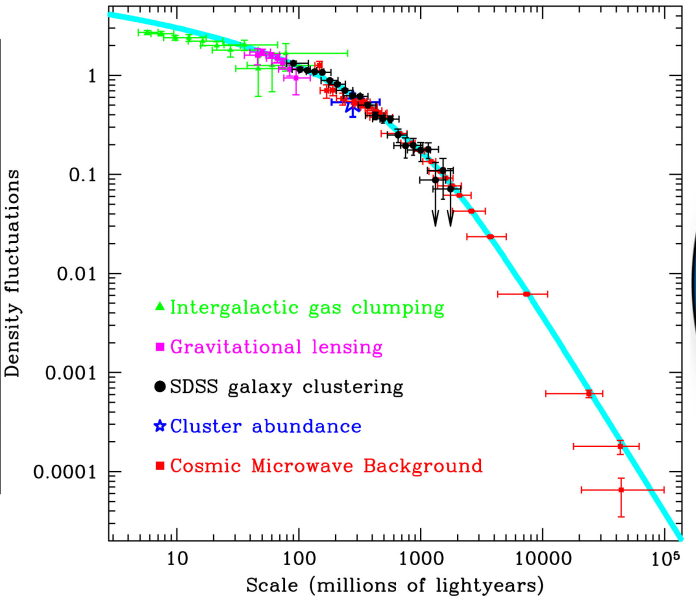
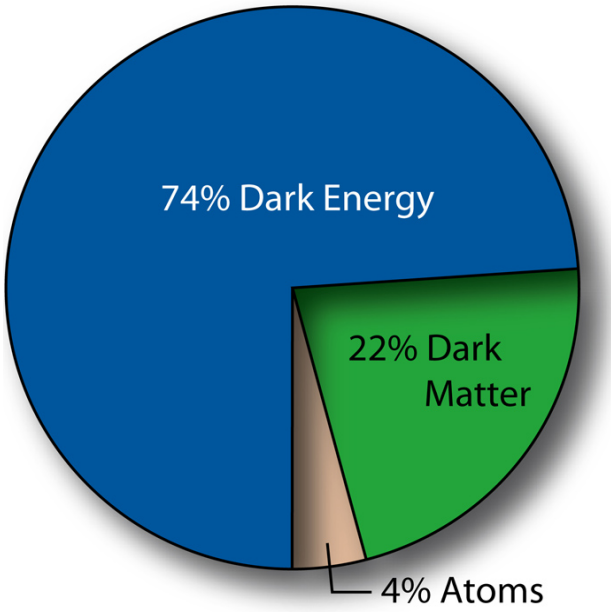
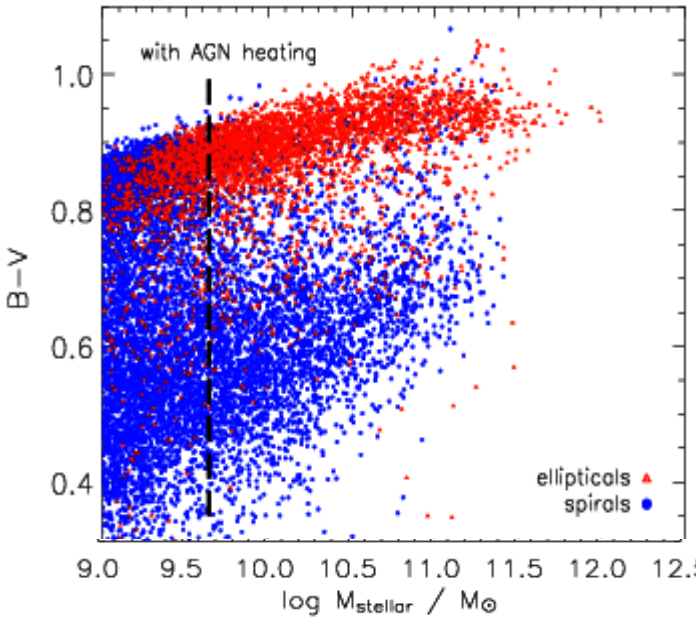

Galaxy formation...

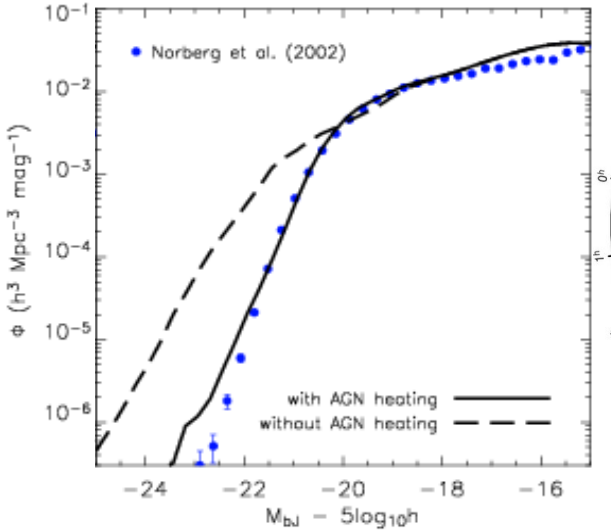


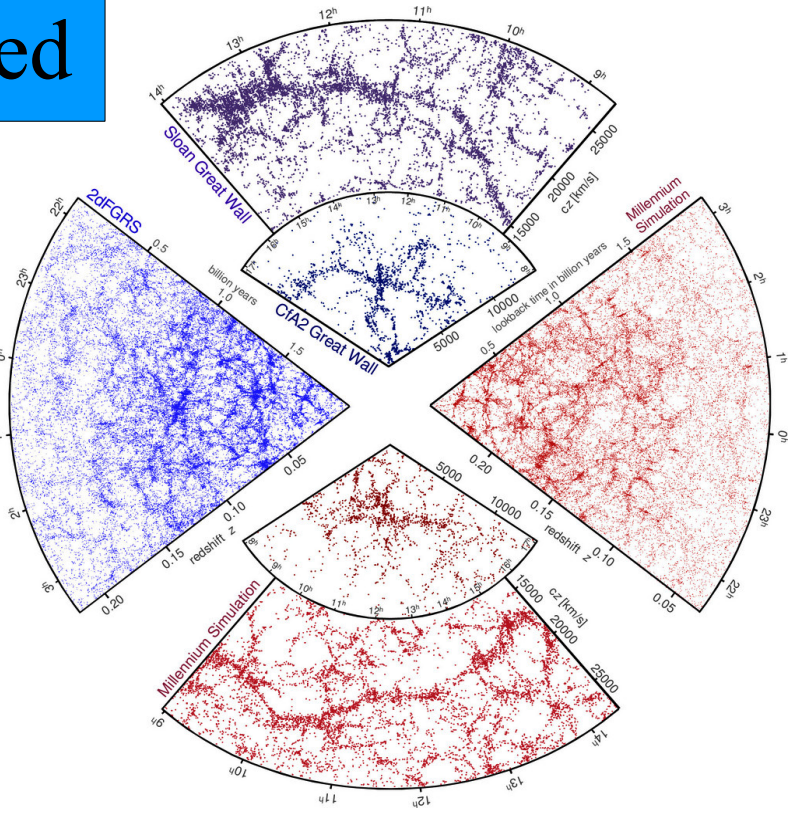






...has been solved





Galaxy Formation.....

- ...starts from small-amplitude, gaussian, near-scale-invariant fluctuations generated in the very early universe...

- ...and imposed in an almost flat FRW cosmology which is today a mixture of ~4% baryons, ~20% DM and ~76% DE.

- Structure grew under the influence of *gravity* to nonlinear amplitudes...

- ...then dissipative processes caused gas to collect at the centres of dark halos and turn into galaxies.

- Star formation and feedback processes regulated the masses, morphologies and structure of the final star/gas/BH objects

Fundamental Questions

- Is there really dark matter? / What is it?
- Is the cosmic expansion really accelerating? / Why?
- Why does the Universe appear flat today?
- Did inflation produce cosmic isotropy? cosmic structure?
- Why is there matter rather than antimatter?
- Are we affected by additional dimensions? other universes?
- Why is the real world described by mathematical laws?

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  +
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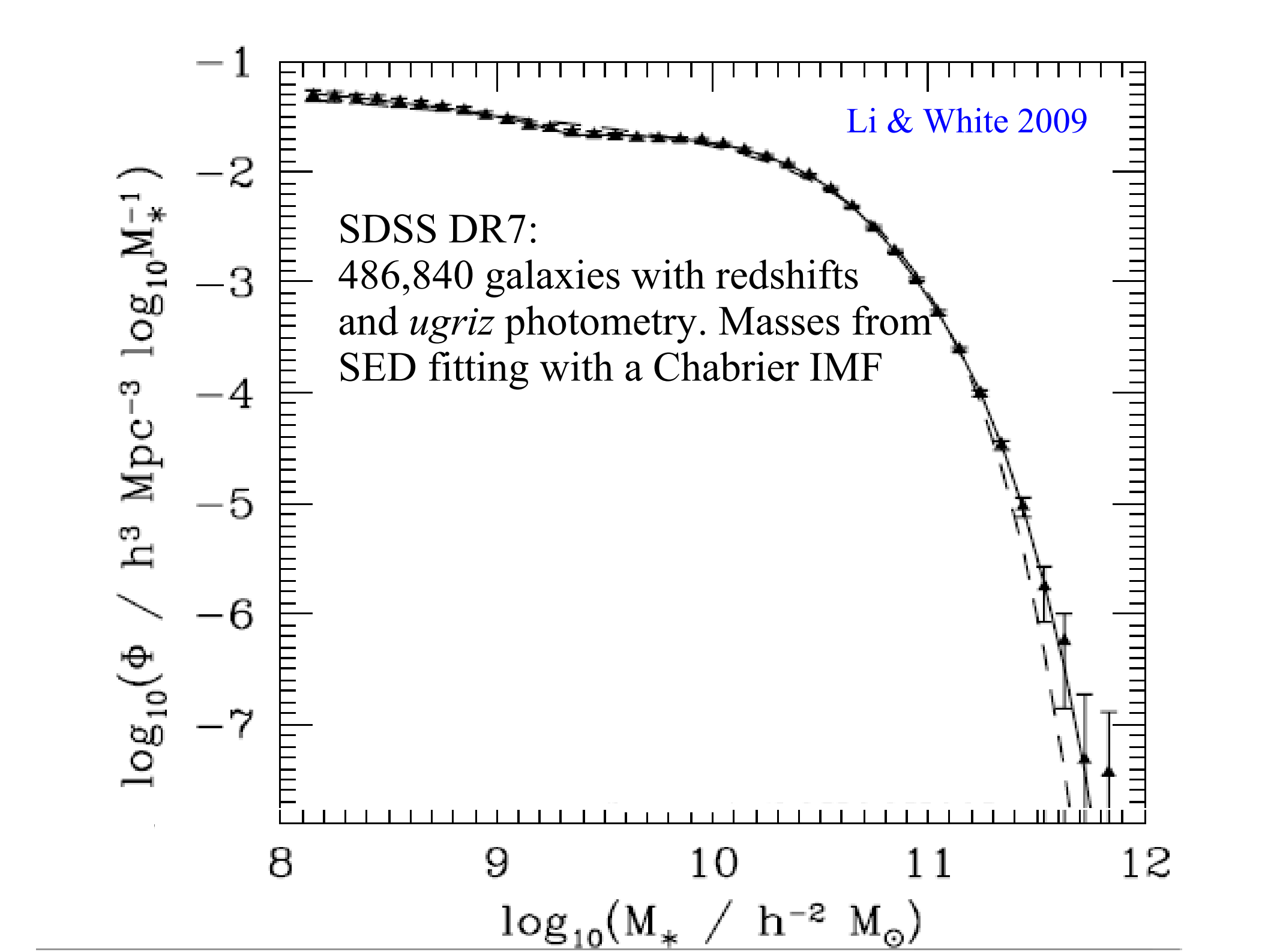
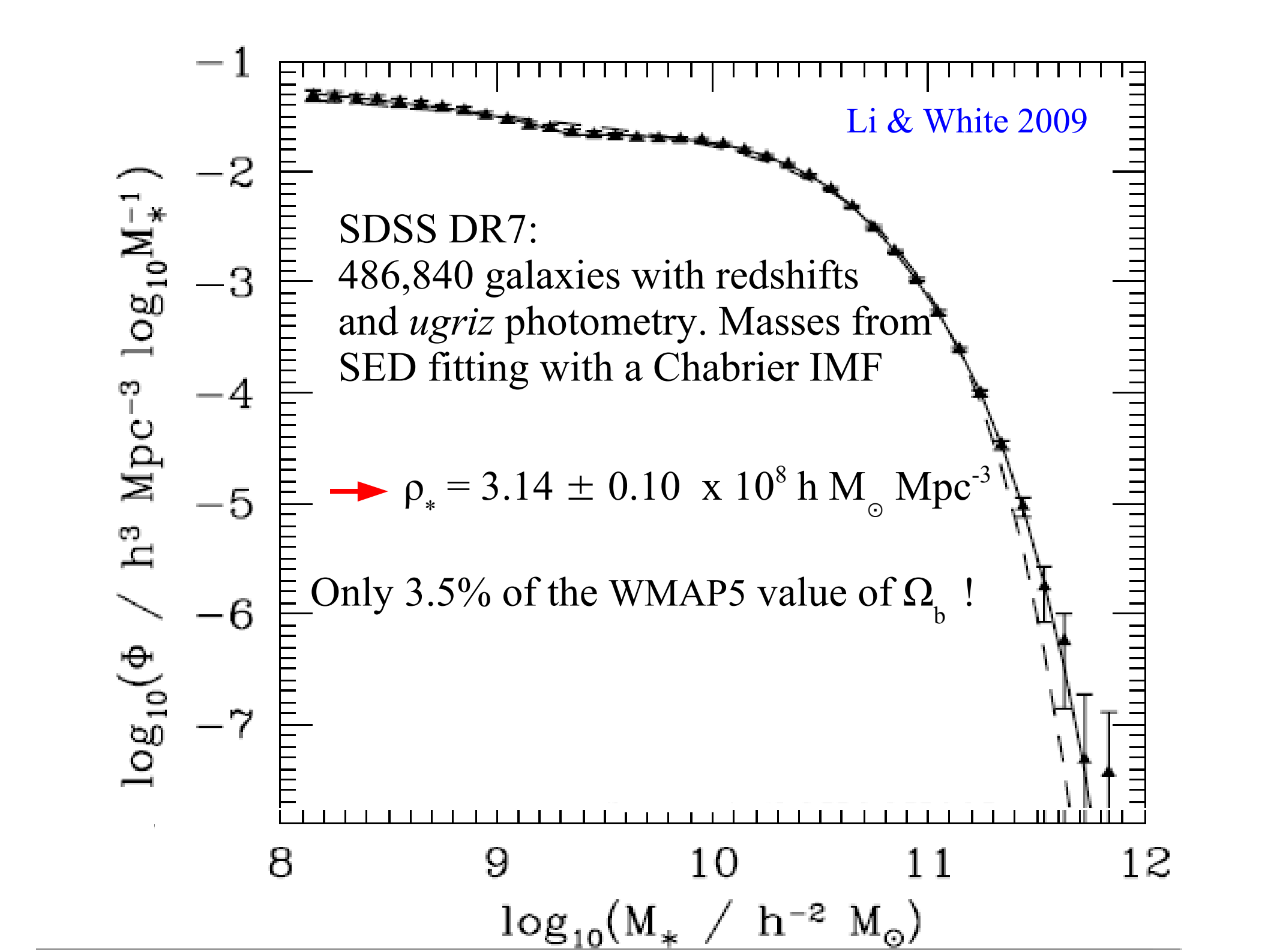
...but are these of current scientific interest?

Interesting Questions: galaxies

- Why was galaxy formation so inefficient?
- What shapes the galaxy mass function at high/low masses?
- What sets the sizes of galaxies?
- What causes the disk/spheroid dichotomy?
- Do disks evolve into spheroids? How? A role for bars?
- How do galaxies grow? How do thin disks survive?
- What role do black holes play? What triggers activity?
- Where do globular clusters fit in? halo populations?
- How do galaxies interact with their environment?
- Does radiation from early galaxies affect later structure?


Li & White 2009
SDSS DR7:
486,840 galaxies with redshifts
and *ugriz* photometry. Masses from
SED fitting with a Chabrier IMF
$\log_{10}(\Phi \ / \ h^3 \ Mpc^{-3} \ \log_{10}M_*^{-1})$
$\log_{10}(M_* \ / \ h^{-2} \ M_\odot)$
−1
−2
−3
−4
−5
−6
−7
8
9
10
11
12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486,840 galaxies with redshifts
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$\rho_* = 3.14 \pm 0.10 \times 10^8\ h\ M_\odot\ Mpc^{-3}$
Only 3.5% of the WMAP5 value of Ω_b !
$\log_{10}(\Phi\ /\ h^3\ Mpc^{-3}\ \log_{10}M_*^{-1})$
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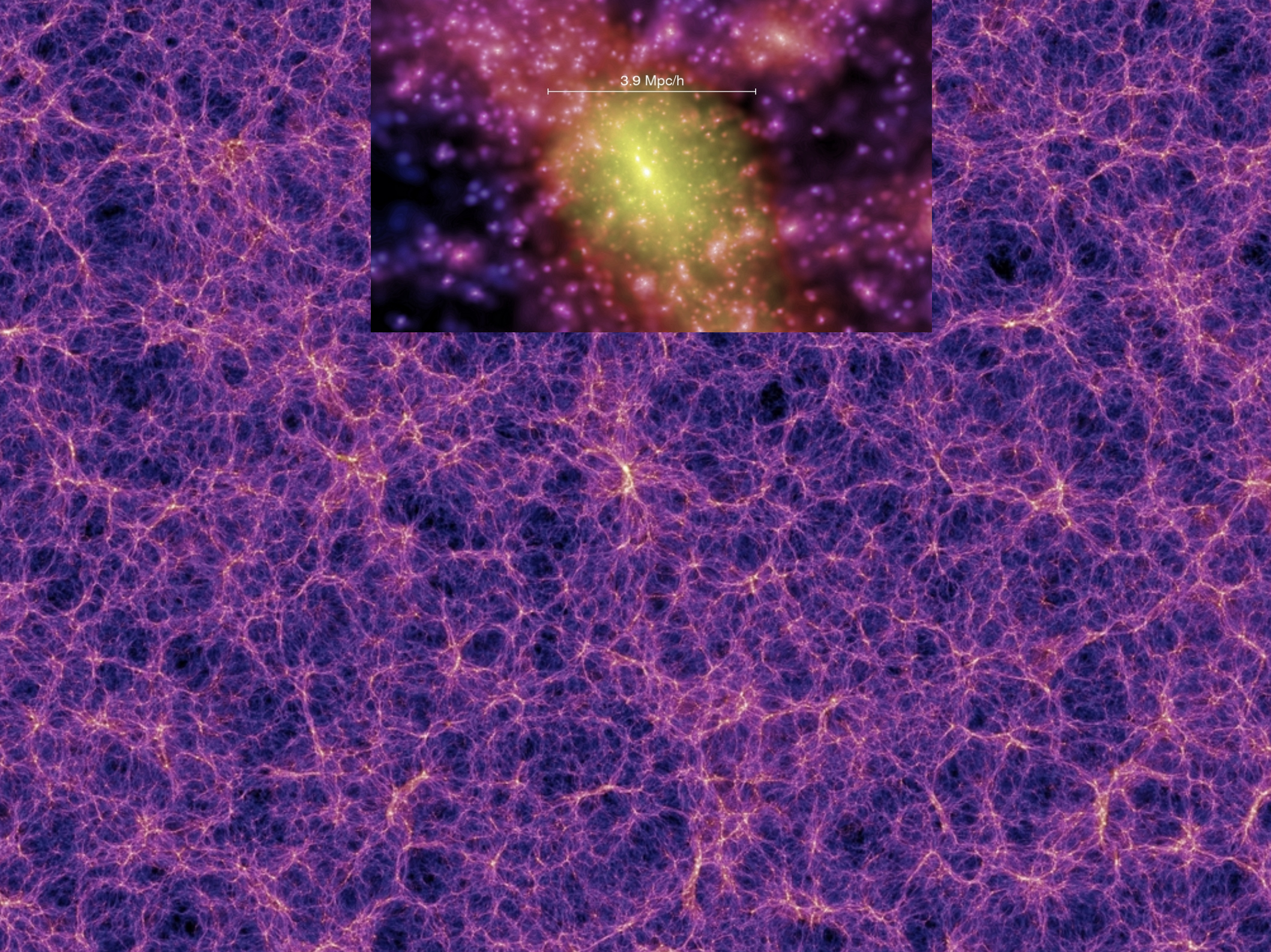
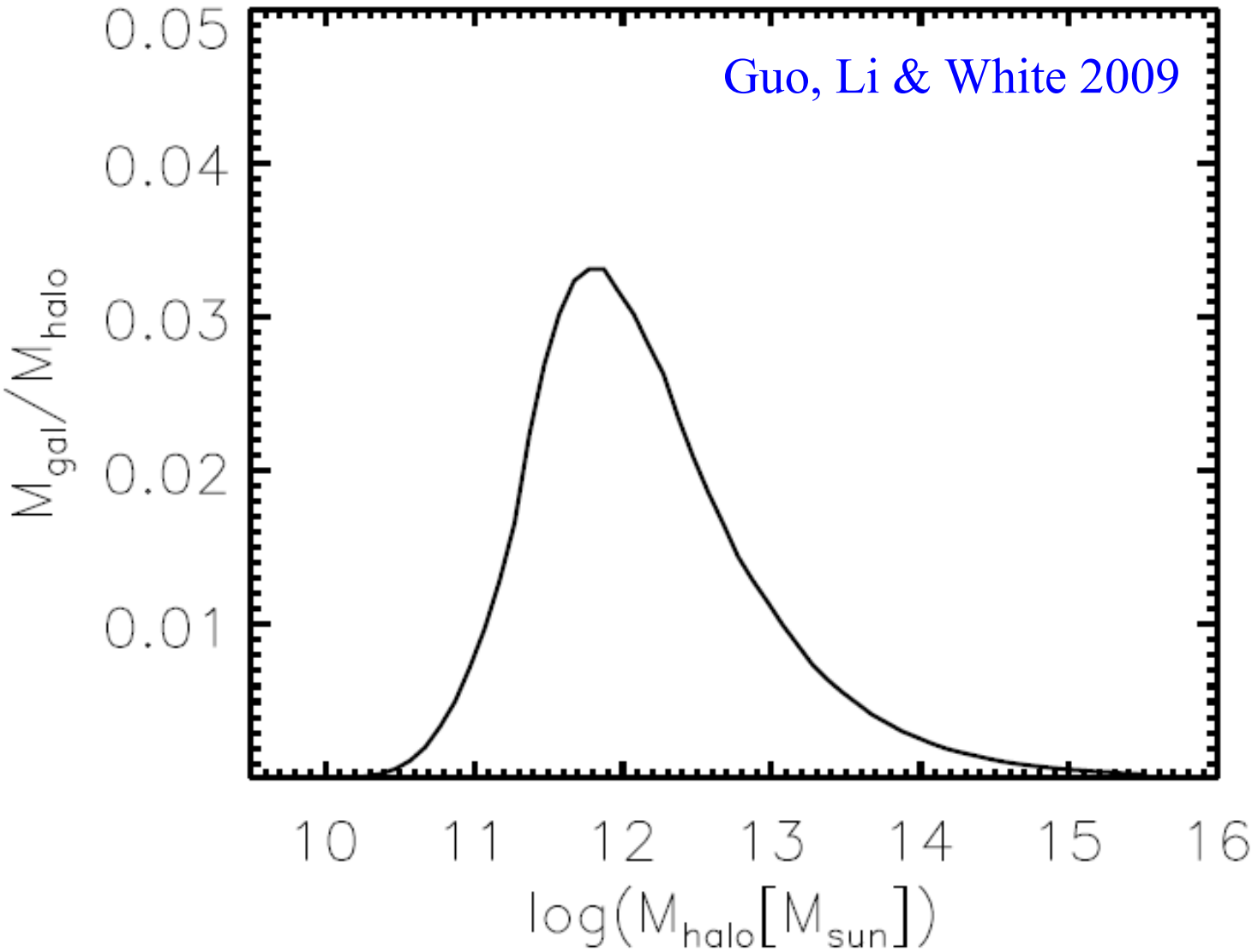
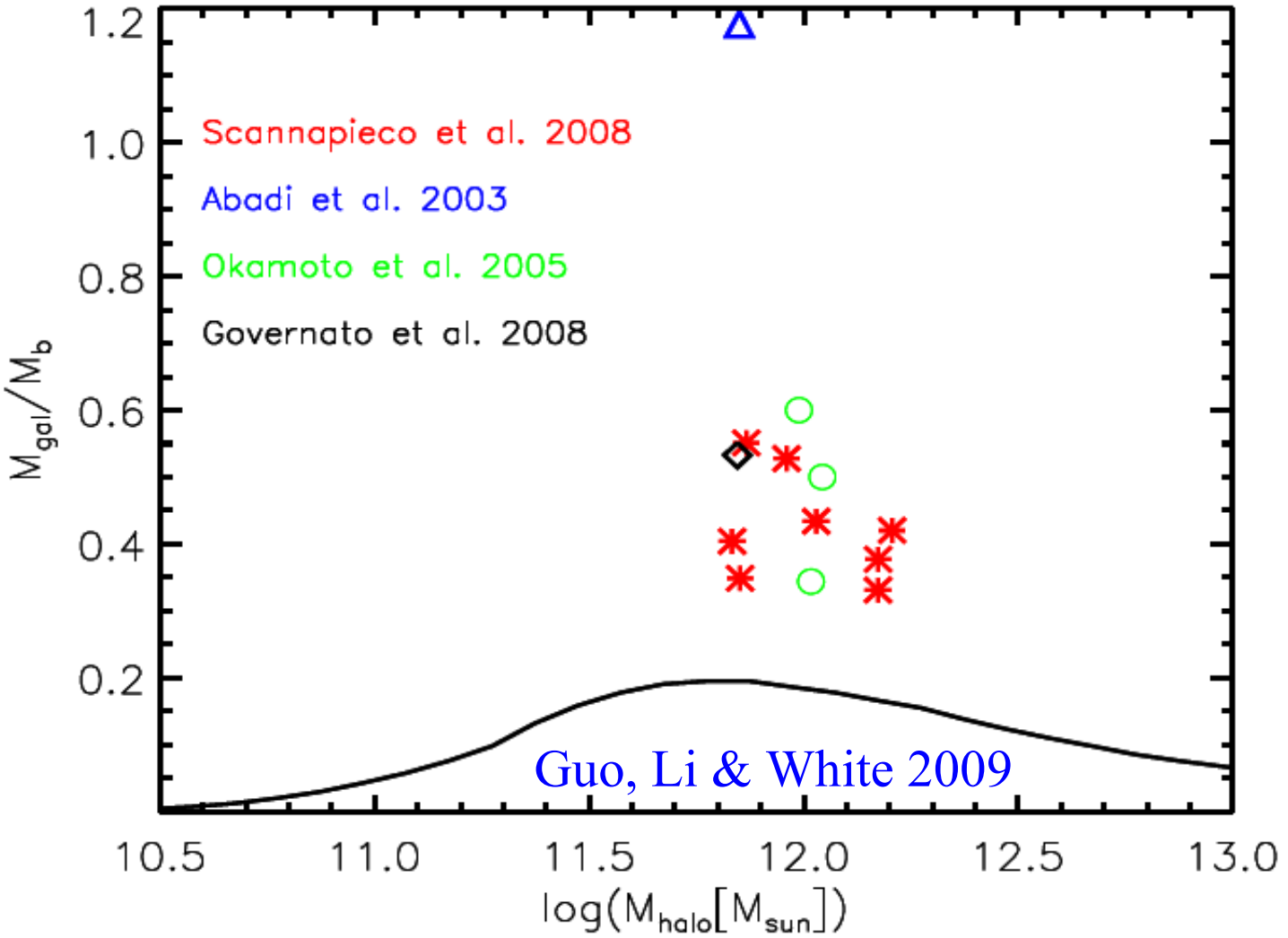

3.9 Mpc/h



- The maximum halo mass fraction in central galaxy stars is 3.5%
- This is attained for halos similar in mass to the Milky Way's halo
- The fraction drops very rapidly to higher and lower masses



- Galaxy formation efficiency is: $\varepsilon = M_* / (\Omega_b M_{h,max} / \Omega_{bm})$
- This *maximises* at about 20% in halos like the Milky Way's
- It is much lower than in all current galaxy formation simulations
- In the Milky Way well over 10^{11} $M_\odot$ of baryons are "missing"

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Interesting Questions: IGM/Z

- Structuring through winds + ionizing radiation:
  --effects on "simple" Ly α forest models: ν masses, cosm.par.
  --enrichment pattern, ionization structure, intergal. dust
  --injection and acceleration of CR, injection of B field
  --relation to UV absorption OVI, OVII, etc.

- Links to chemistry and structure growth in Milky Way/LG
  --timescales for SNIa/CNO enrichment, component assembly
  --searching for tidal extensions/streams from LG dwarfs

- Insights into galaxy group/cluster structure and growth
  --dynamics/stripping/wind ejection
  --evolution of IGM abundances (X-ray) vs galaxy pops
  --galaxy pop.'s versus cluster mass, structure, radius, redshift

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and don't forget COS, ALMA, lensing surveys, SKA, JWST...