Dark Energy, Weak Lensing, and Galaxy Formation

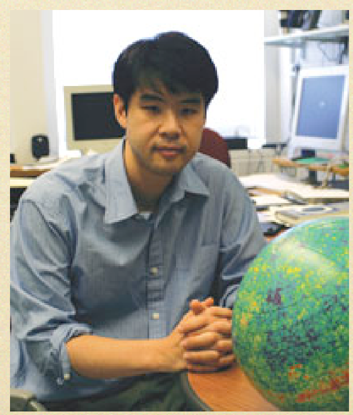
Andrew R. Zentner

University of Pittsburgh

Collaborators

- Douglas Rudd (IAS)

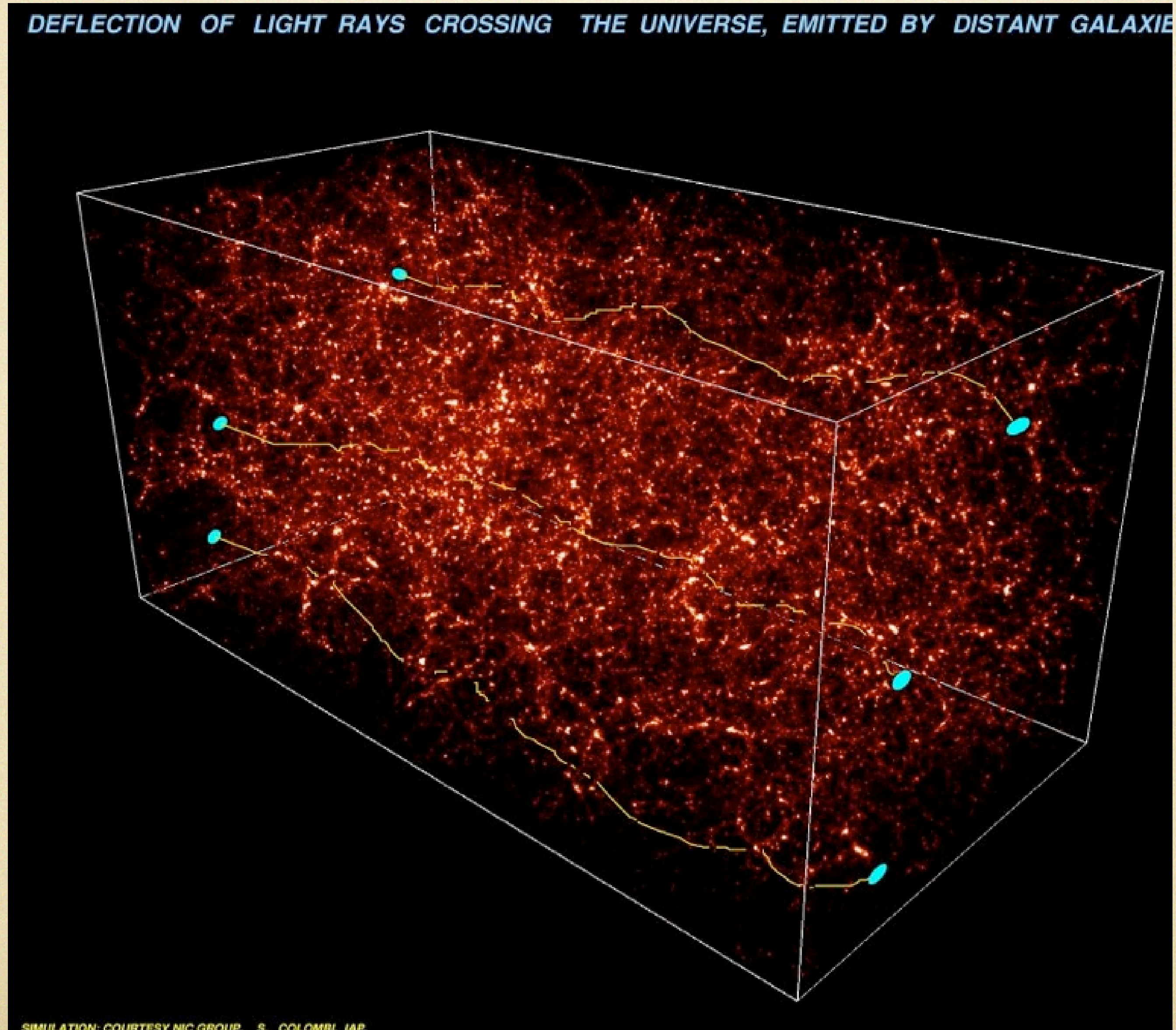
-  Andrey Kravtsov (Chicago)



- Wayne Hu (Chicago)

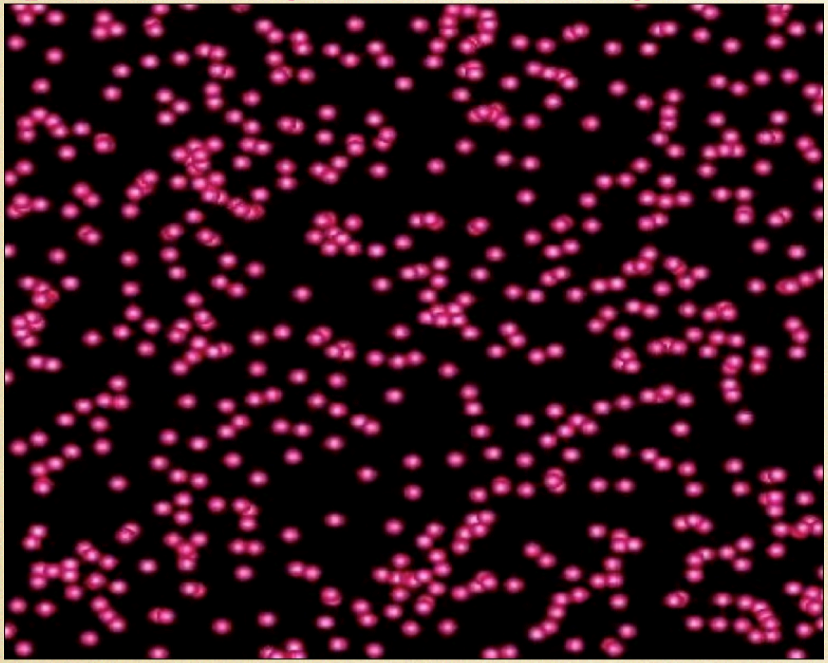
Based on arXiv:astro-ph/0703741 and arXiv:0709.4029

Weak Lensing

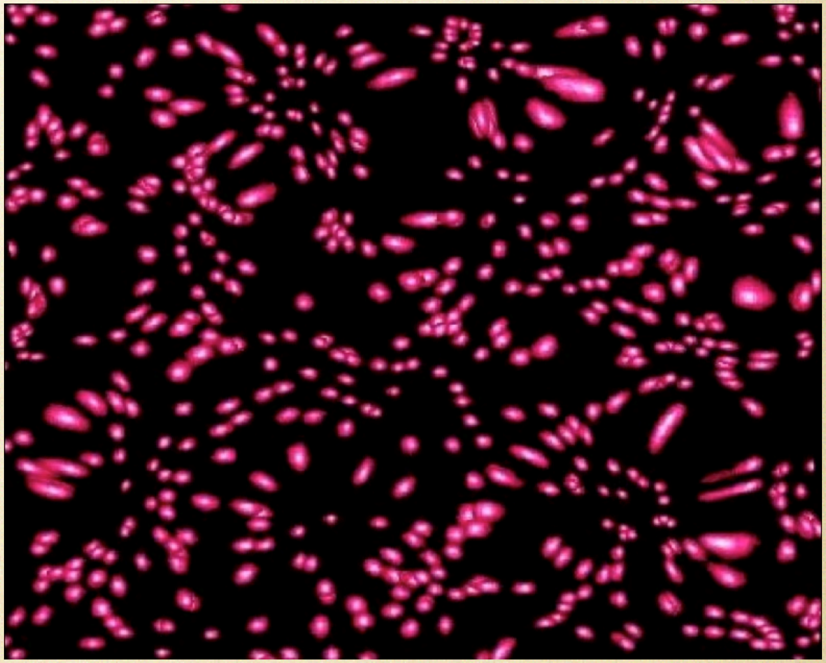


Cosmic Shear

http://aether.lbl.gov/Weak_Lensing



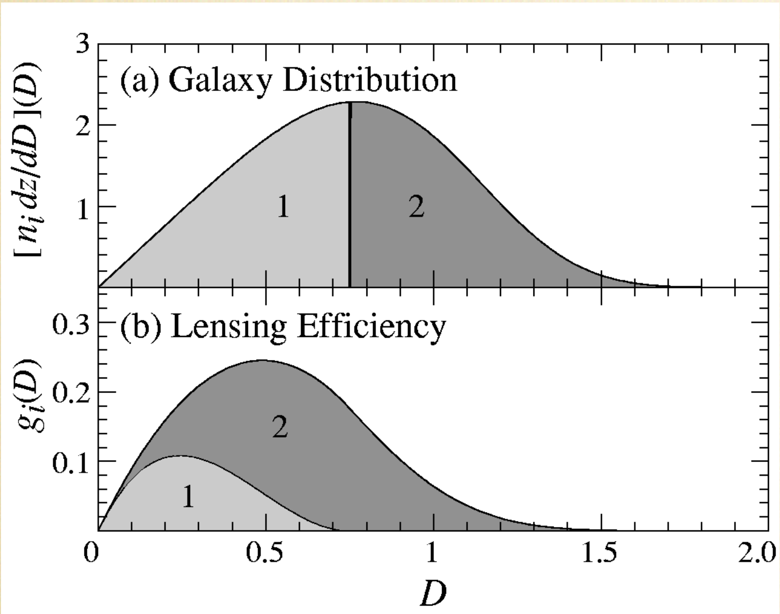
intrinsic sources

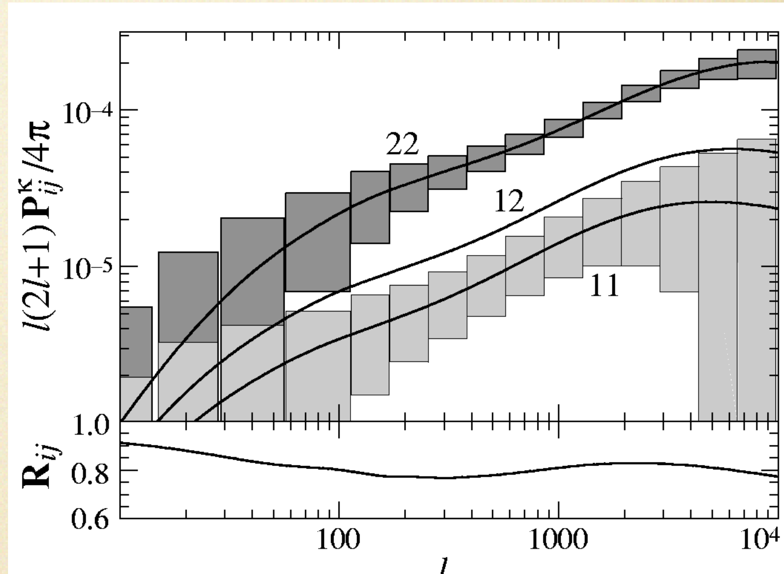


lensed

- The lensing manifests as correlated distortions of galaxy ellipticities

Convergence Spectra





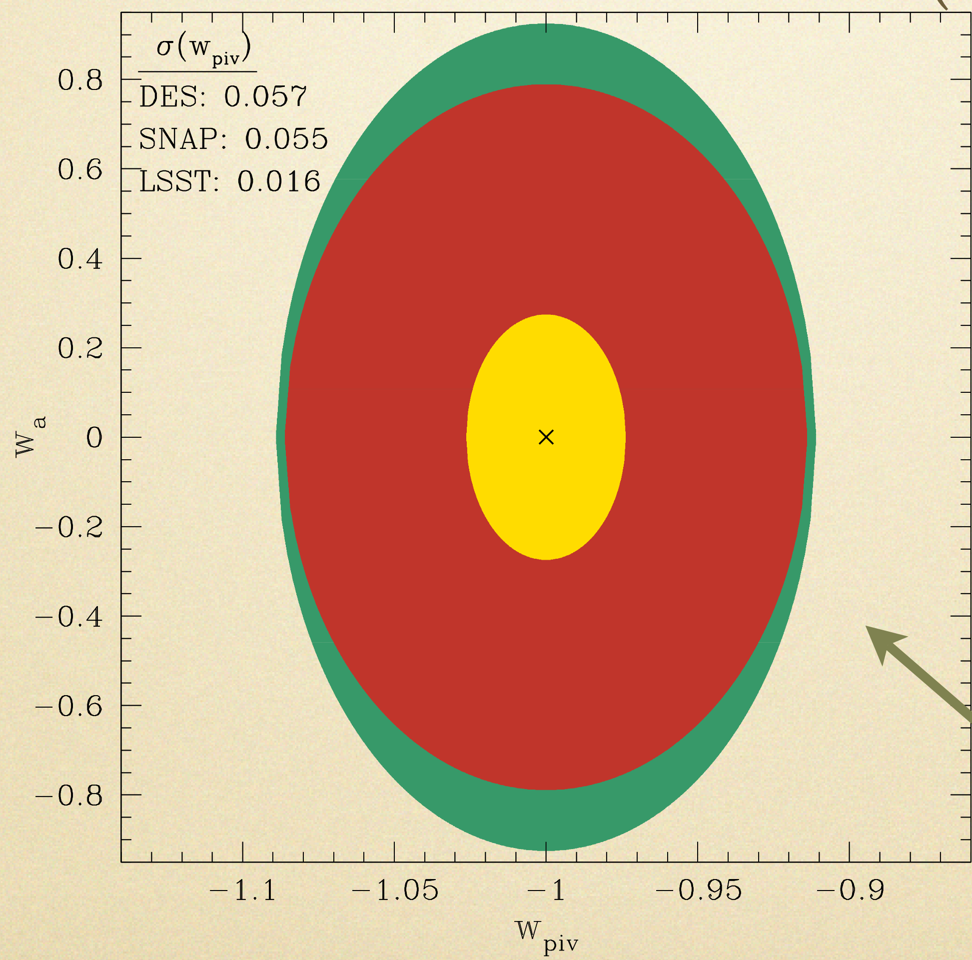
Hu 99

- Convergence power spectra are standard observables and can constrain dark energy
- Tomography refers to the use of multiple source samples to obtain distance/redshift information

A Standard DE Forecast

$w(a) = w_0 + (1-a)w_a$

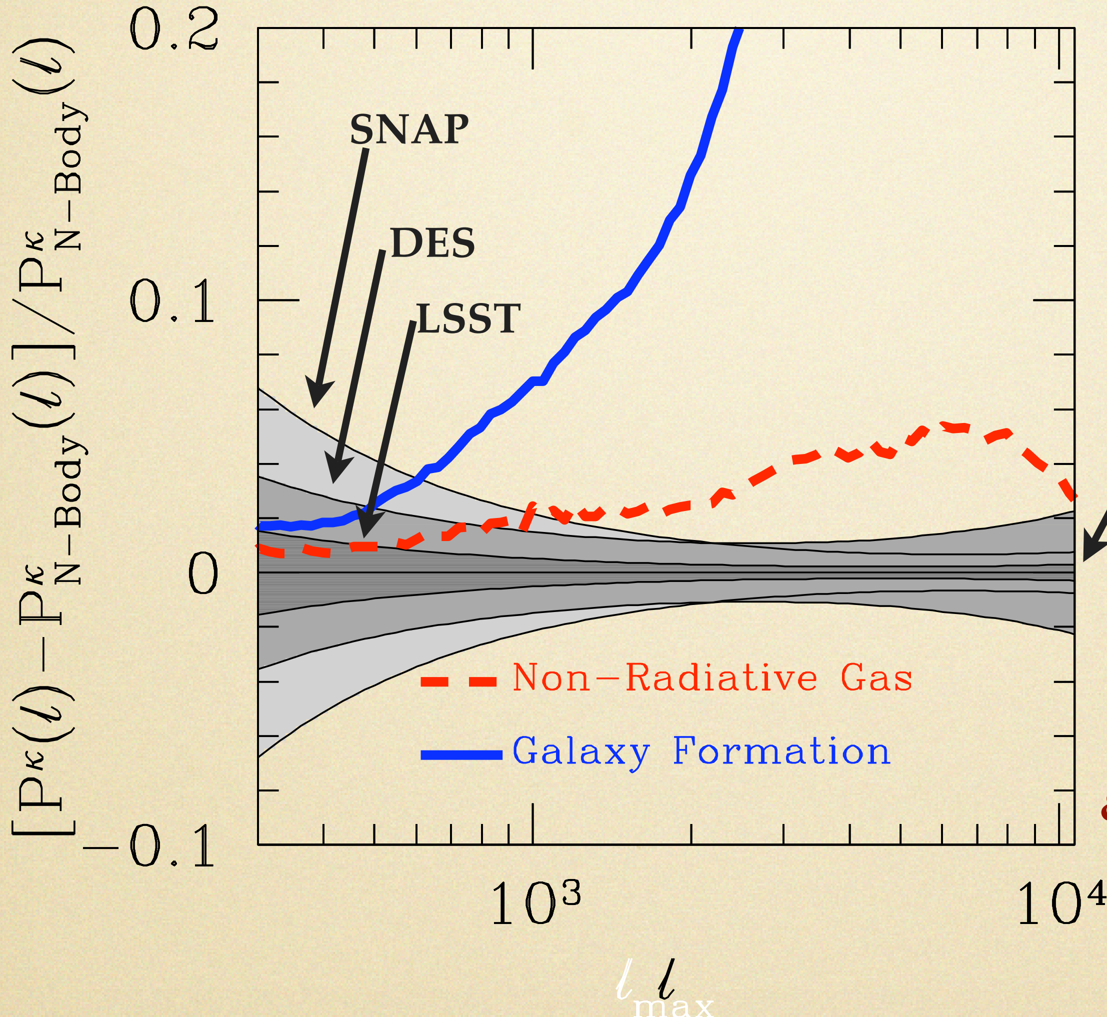
First order evolution with scale factor



from WL only!

w(a) at pivot scale factor

Including Baryons!



SNAP Better Here

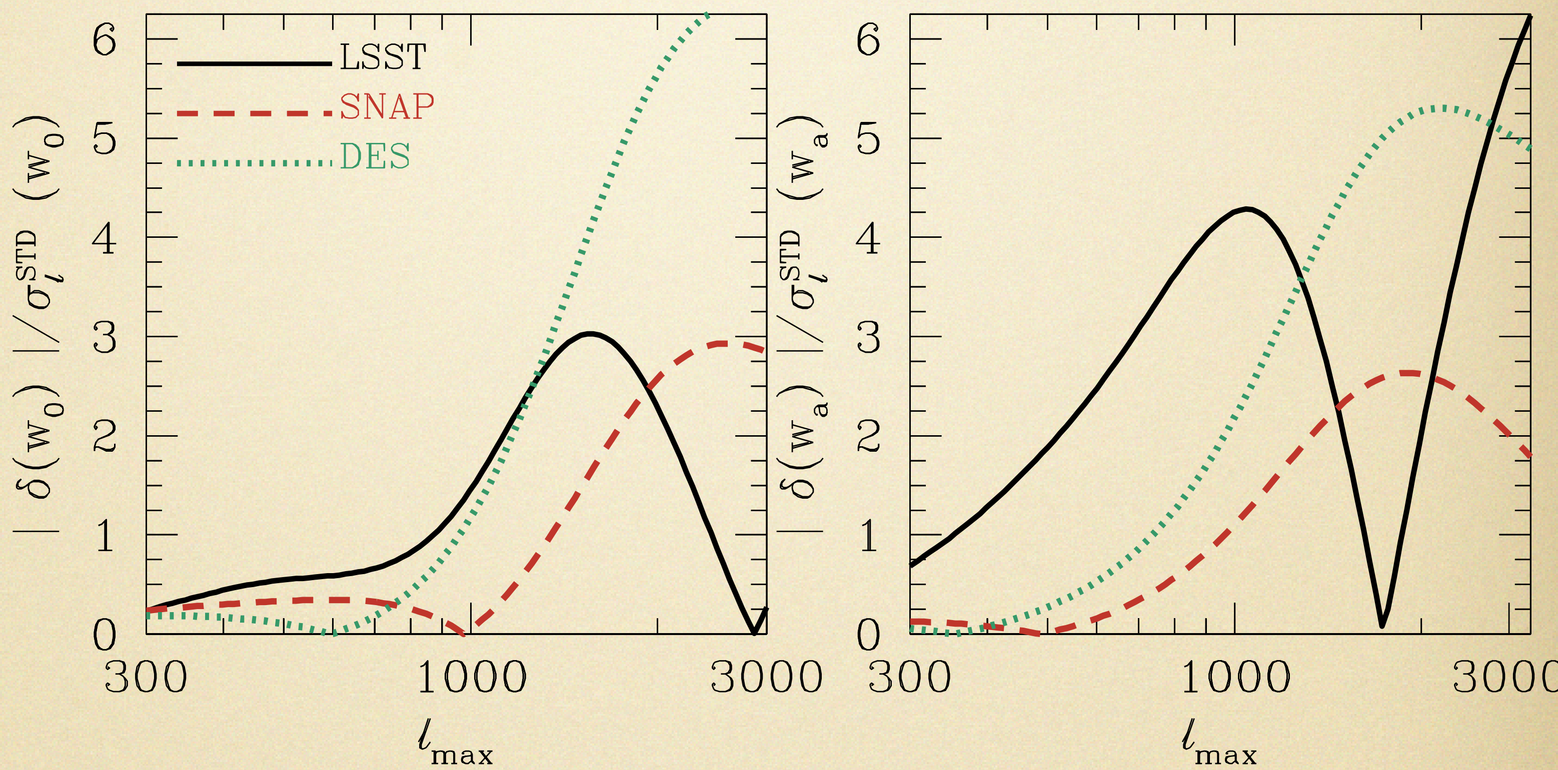
also, White 2004; Zhan & Knox 2004; Rasia et al. 2004; Jing et al. 2006

& Stanek Poster Behind You!

- Baryons alter predictions significantly at large multipoles

DE Parameter Bias

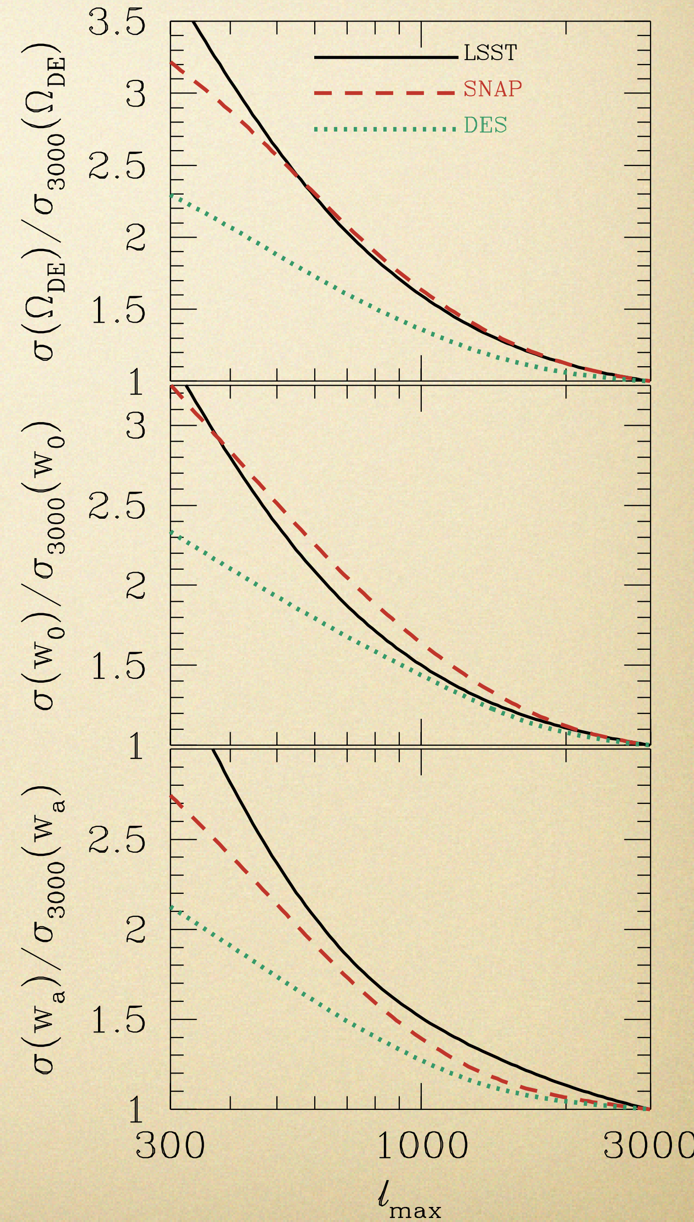
Parameter Bias Relative to Statistical Uncertainty



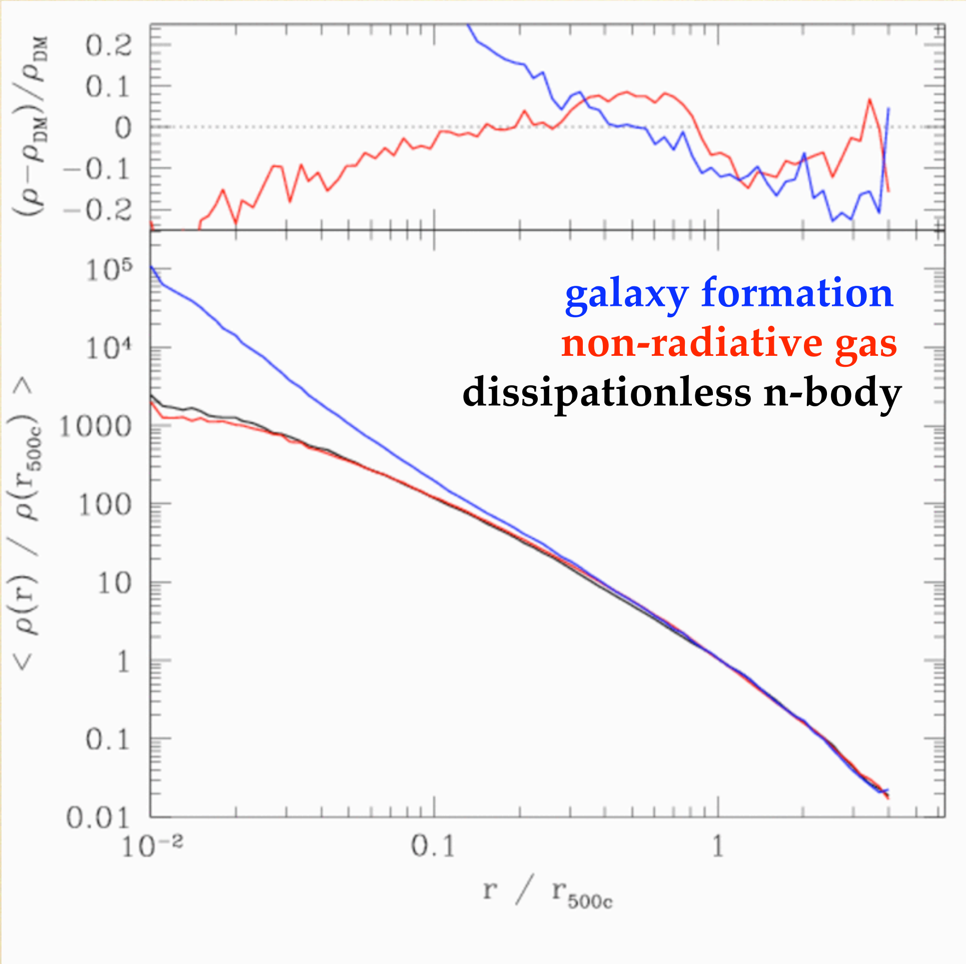
Maximum Multipole Under Consideration

Excise Small-Scale Information

- Scaling of statistical error with maximum multipole (relative to errors at $\ell_{MAX} = 3000$)
- Removing small-scale information to eliminate bias expands statistical error by a factor of ~ 2-4



Halo Concentrations

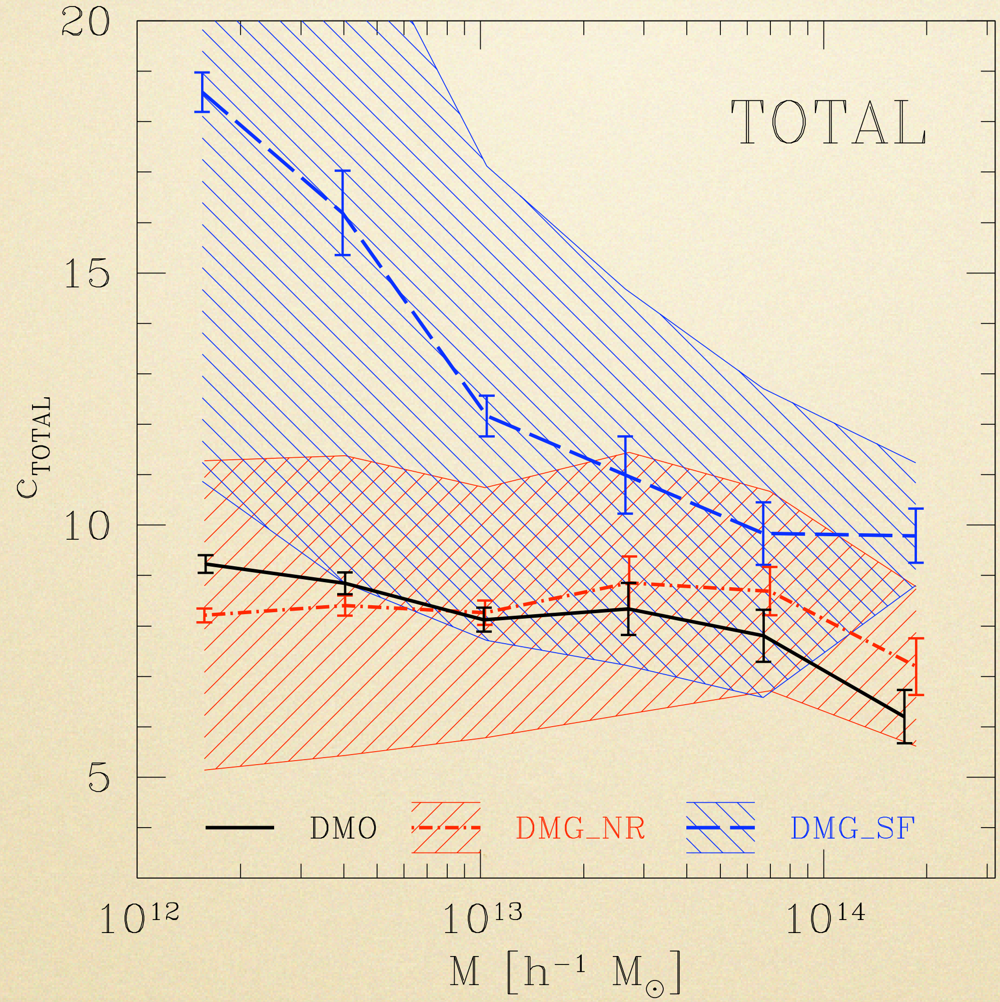


Rasia et al. 2004;
Lin et al. 2006

& Stanek Poster Behind You for Mass Functions ... !

- The largest effect is due to changes in halo structure

Halo Concentrations

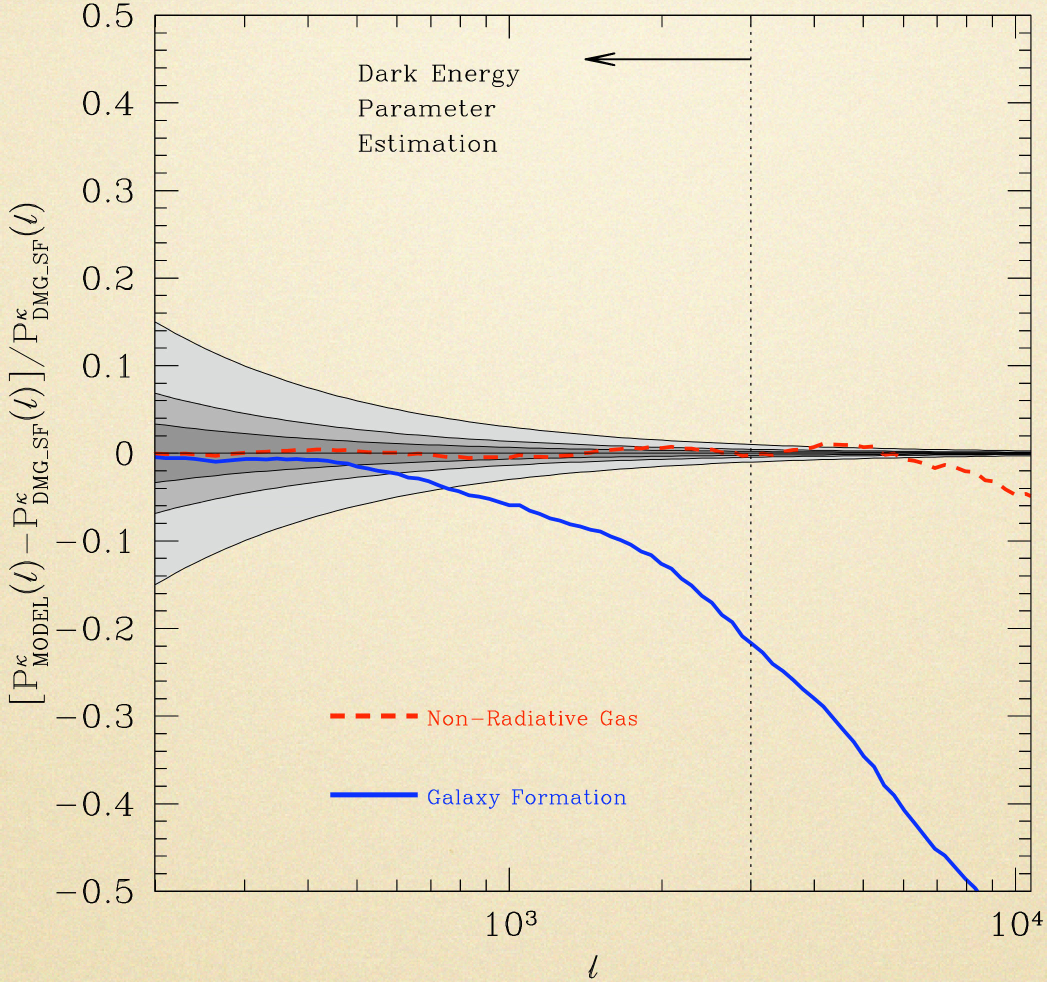


galaxy formation
non-radiative gas
dissipationless n-body

Concentrations for total matter profiles

- The concentration-mass relation for simulated halos can be used to model the convergence power spectra

Modeling Baryons



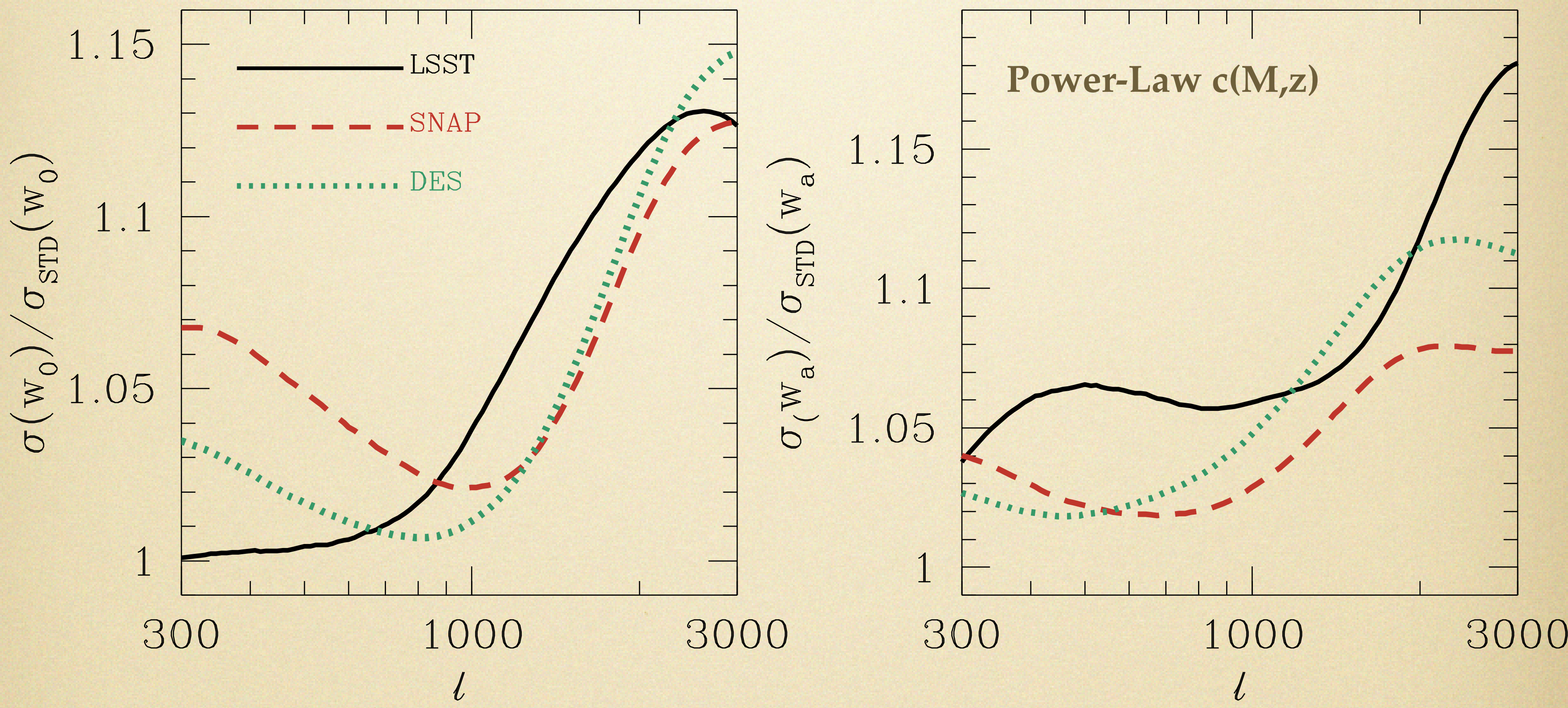
- Model reduces DE parameter biases to < 10% of statistical uncertainties

"Self Calibrate" Concentrations

- Let the concentration-mass relation float and be determined along with cosmology
- Two Models
    - Power law: $c(M,z) = c_0\,(M/M_\star)^{-\alpha}(1+z)^{-\beta}$

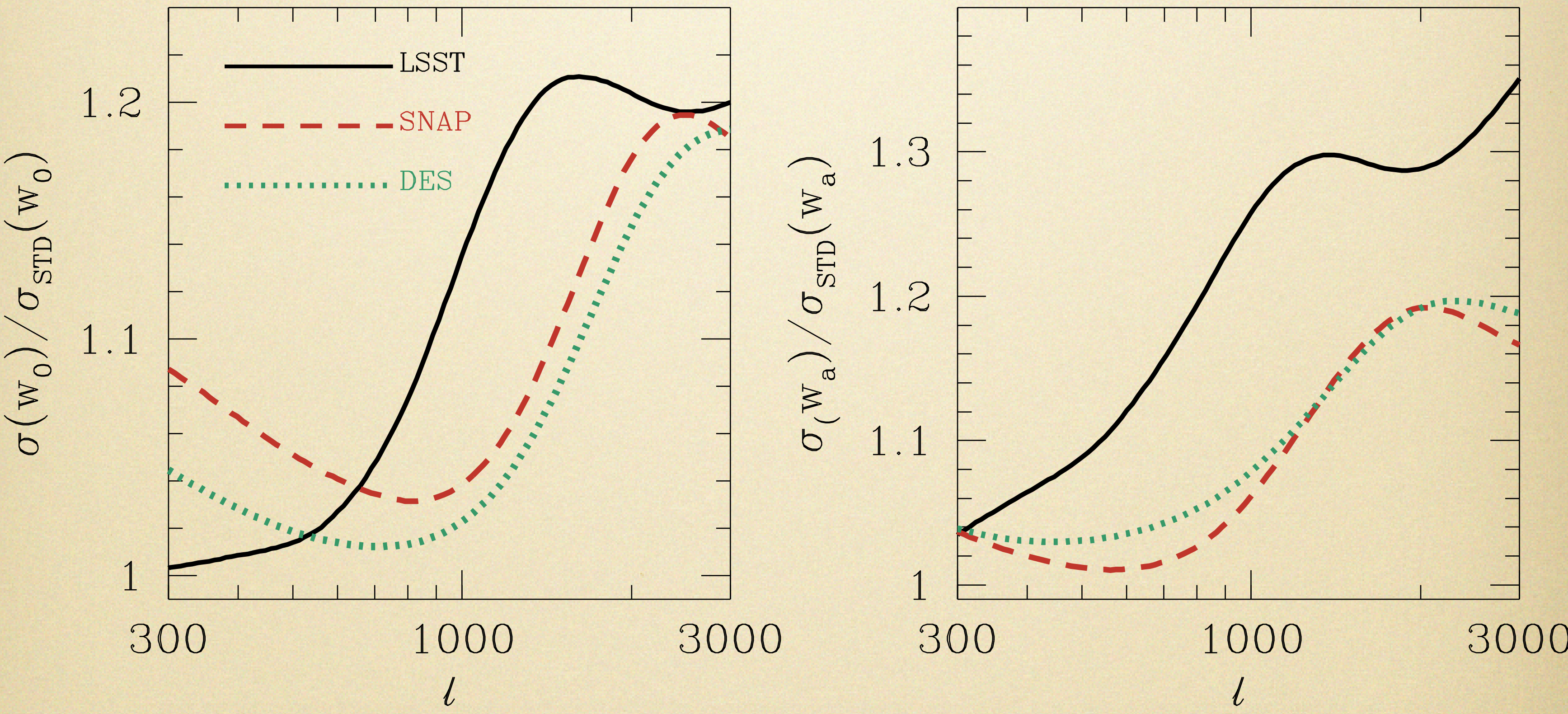
      where α~0.05, β~1 in N-body case
    - General: let c(M,z) be set independently in a set of bins

Parameter Degradation with Self Calibration

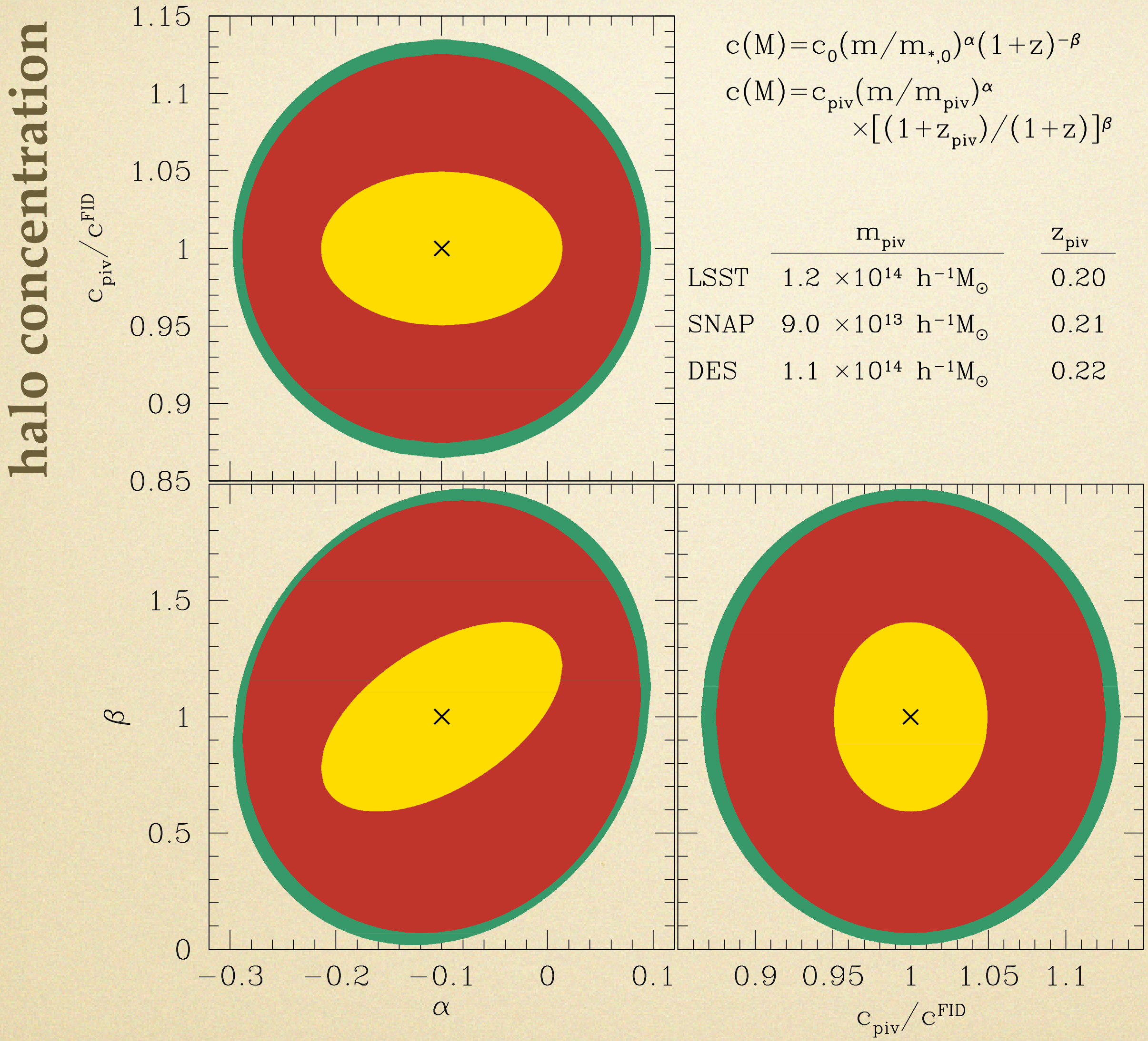


- Even in this simplistic model, self calibration drastically reduces bias yet it only slightly expands constraints

Parameter Degradation with Self Calibration



Constraints on Concentrations

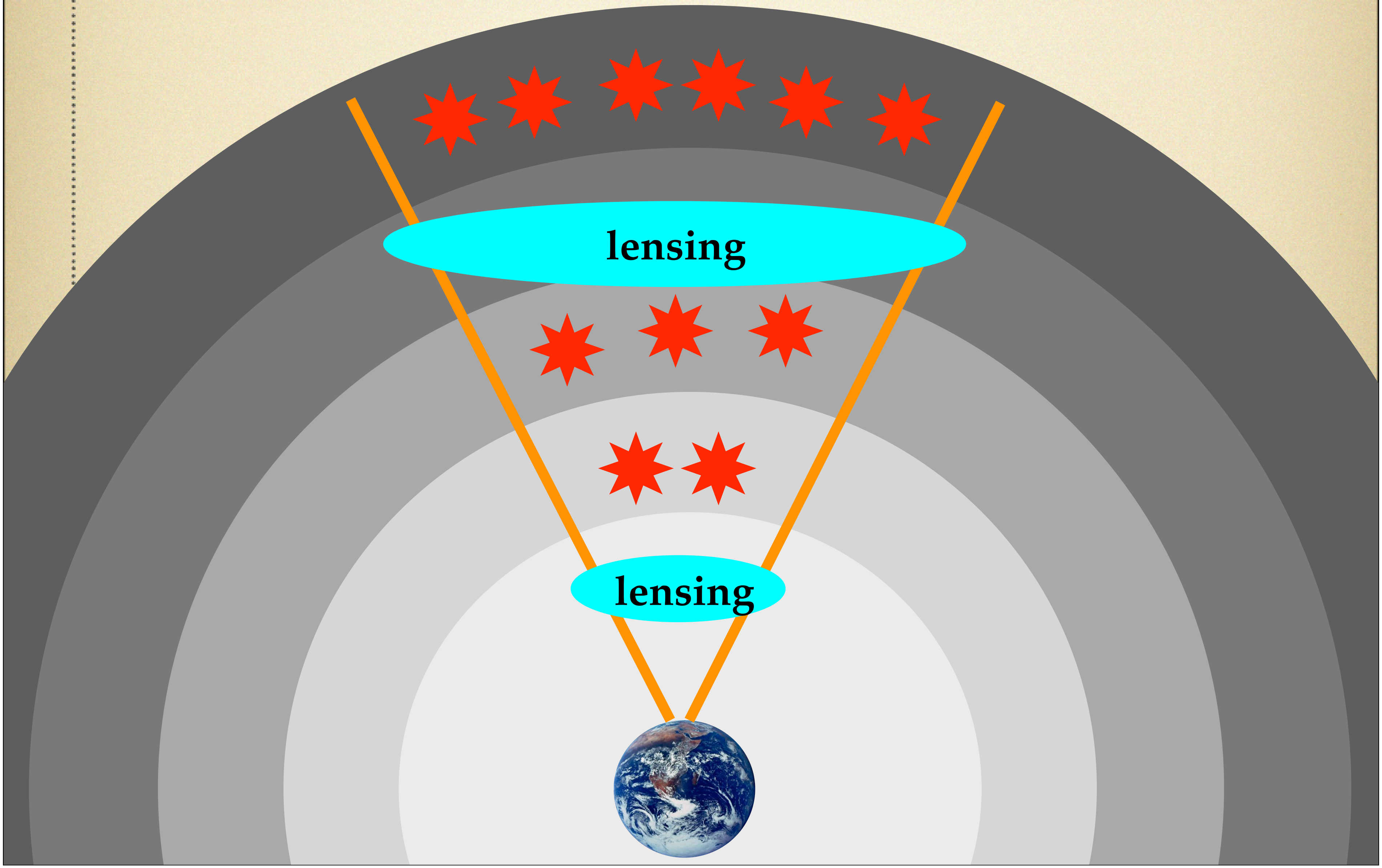


- Constraints on baryonic physics could well be at meaningful levels

In Addition ...

- Tomography is critical ...
- Priors on concentrations that are better than 30% lead to rapid improvements in DE parameters
- Galaxy correlation information will be critical
- High- ℓ information will help
- Need to consider this in much more detail

Tomography



In Addition ...

- Tomography is critical ...
- Priors on concentrations that are better than 30% lead to rapid improvements in DE parameters
- Galaxy correlation information will be critical
- High- ℓ information will help
- Need to consider this in much more detail