

Simulation Calibration of Cluster WL Mass Measurements with DC2

Joe Hollowed, Lindsey Bleem, Patricia Larsen, Nan Li, Steve Rangel, Salman Habib, Katrin Heitmann, Dan Korytov, Andrew Hearin, Eve Kovacs, + the Argonne CPAC and DC2 teams

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- ▶ Uncertainty in MOR is currently the limiting factor for cluster-based cosmology
- ▶ Direct mass calibration possible through weak gravitational lensing using N-body simulations
- ▶ Current WL calibration efforts limit systematic uncertainties to 5 –10% in cluster mass

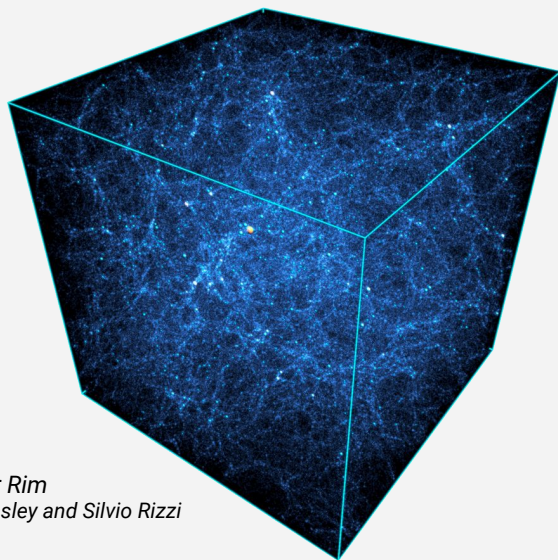
$$M_{\text{WL}} = b_{\text{WL}} M_{\text{true}}$$

↓

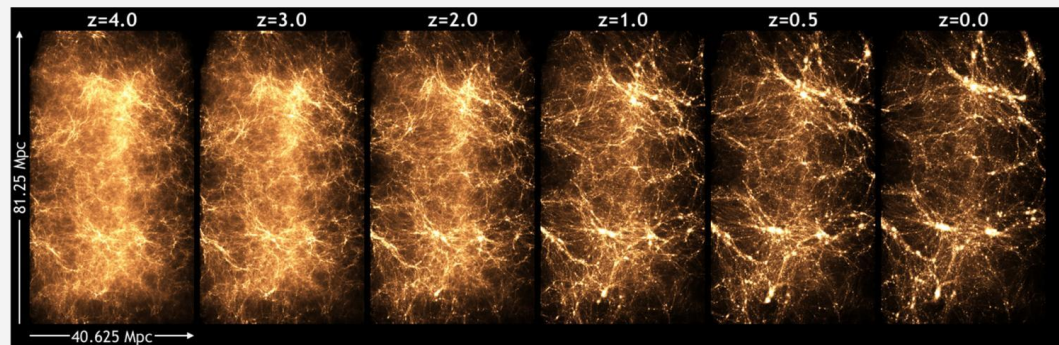
$$P(M_{\text{WL}} | M_{\text{true}})$$

location $\mu = f(b_{\text{WL}})$

scatter σ_{WL}

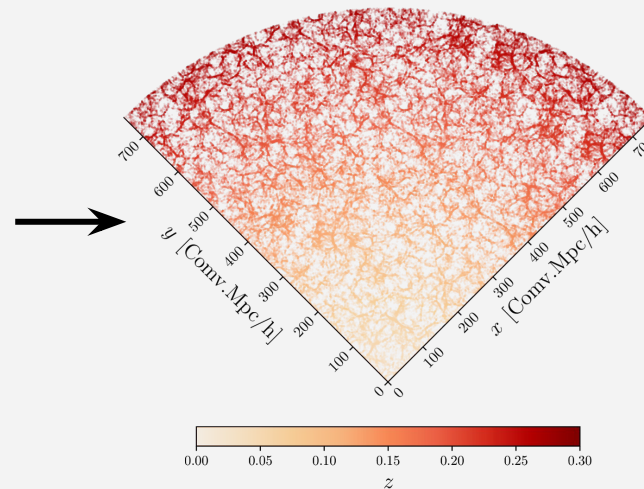
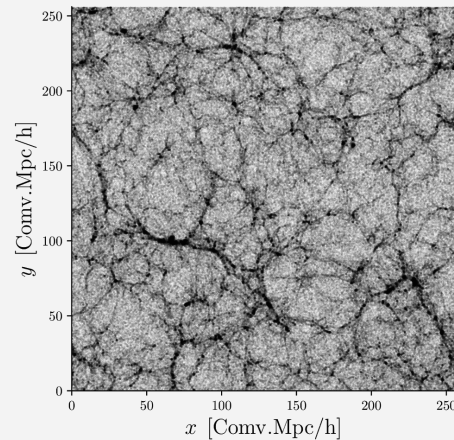


Outer Rim
Joe Insley and Silvio Rizzi

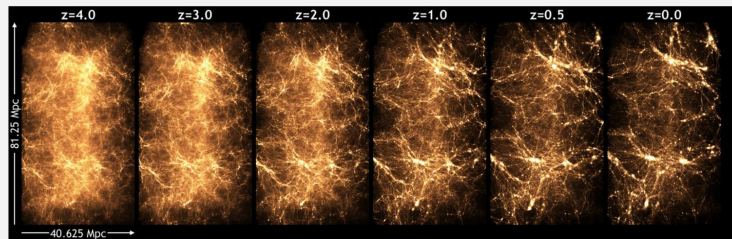


Q-Continuum
Heitmann et al. 2014

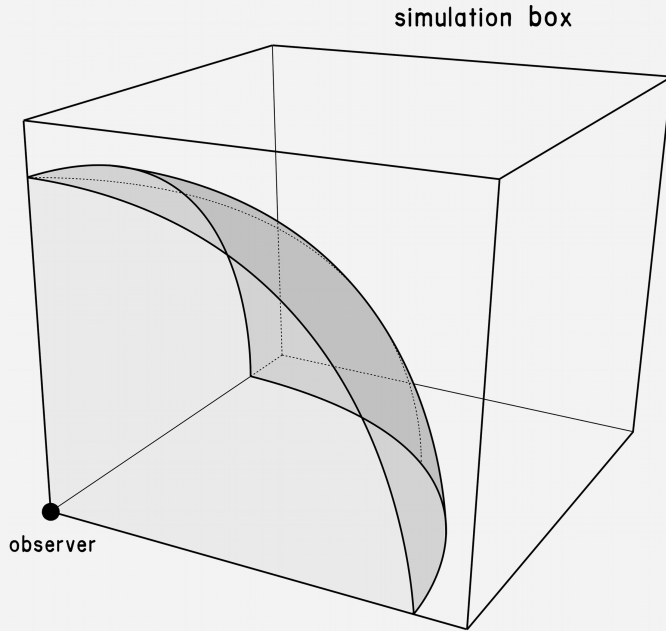
Lightcone Construction to Ray Tracing



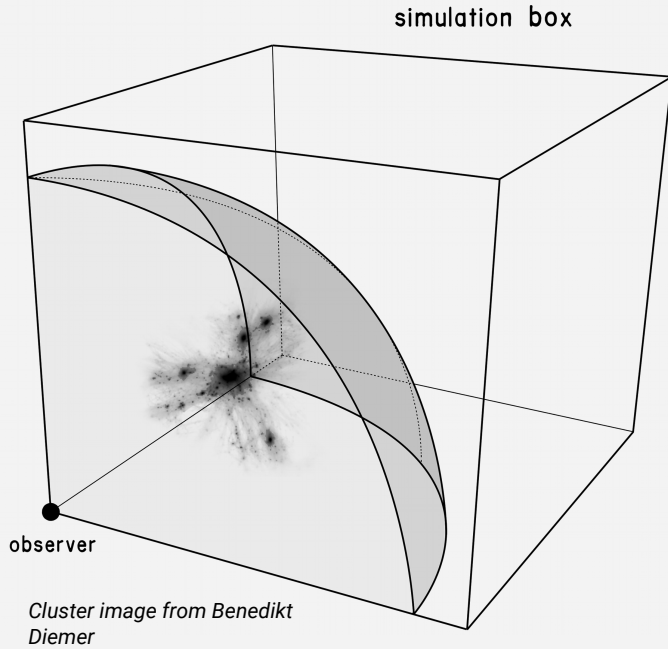
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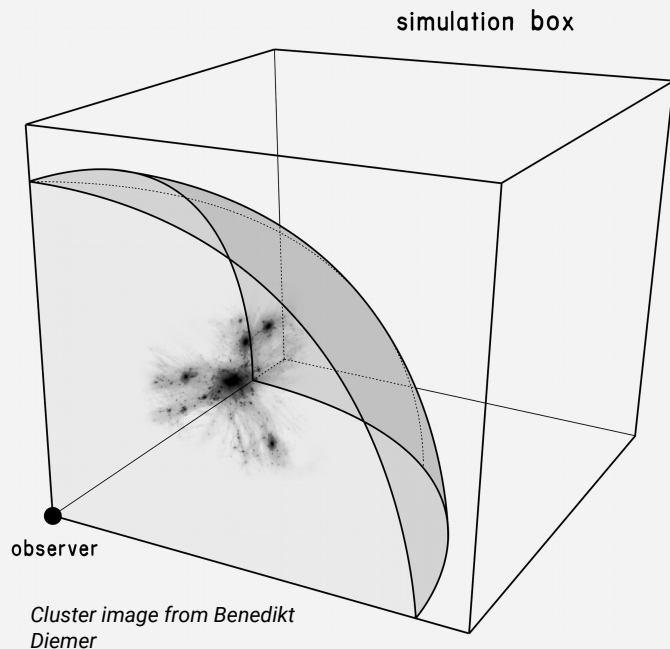


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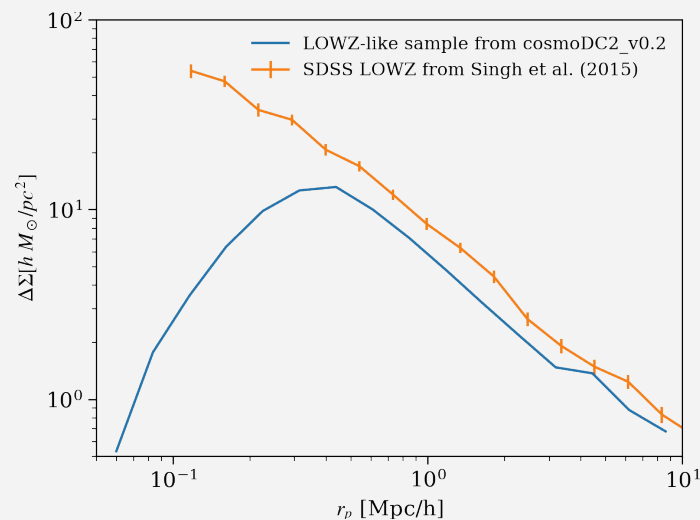
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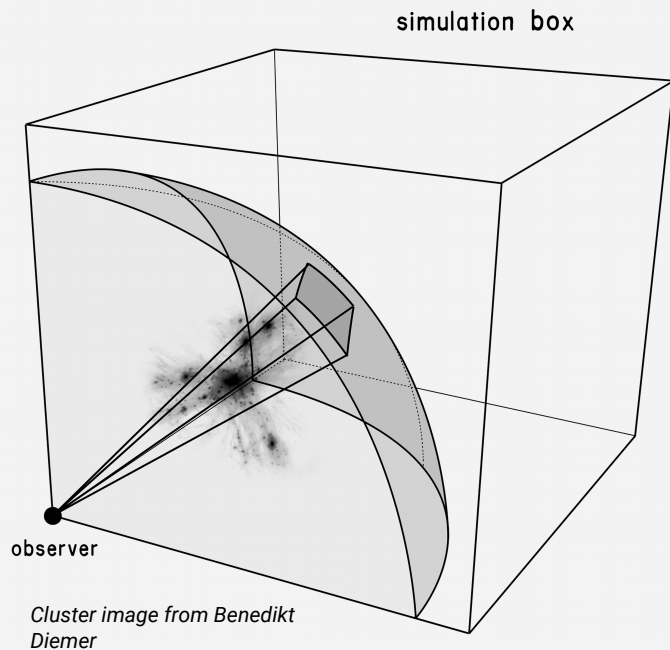




cosmoDC2:

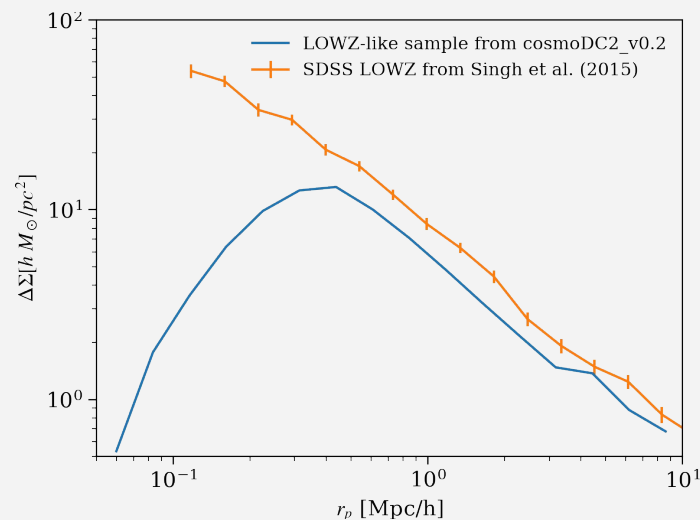
- particle mass: $\sim 1.8 \times 10^{11} M_{\odot} h^{-1}$
 - lensing map pixelization: $\sim 0.8'$
- ... not sufficient!



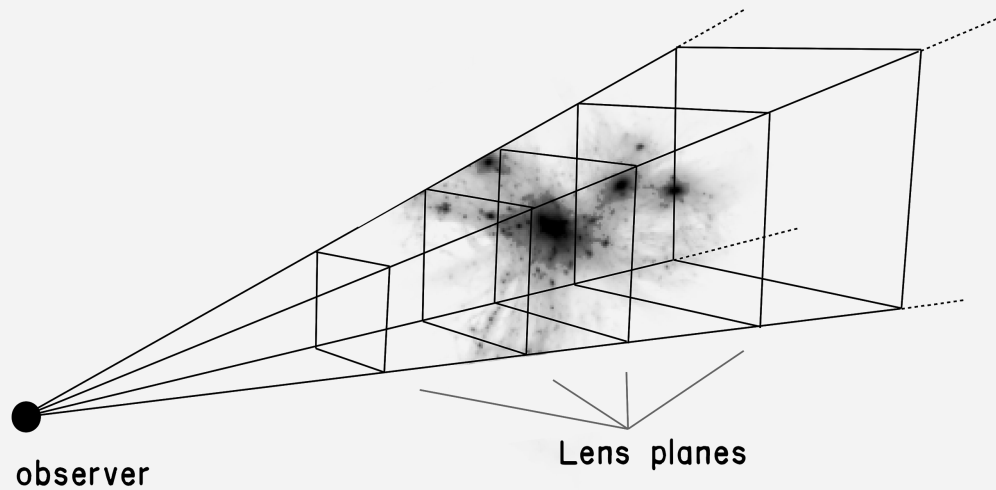
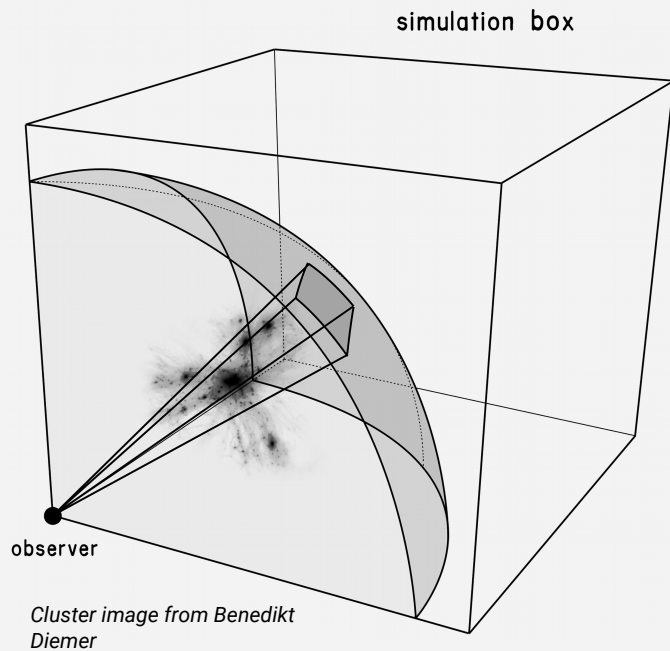


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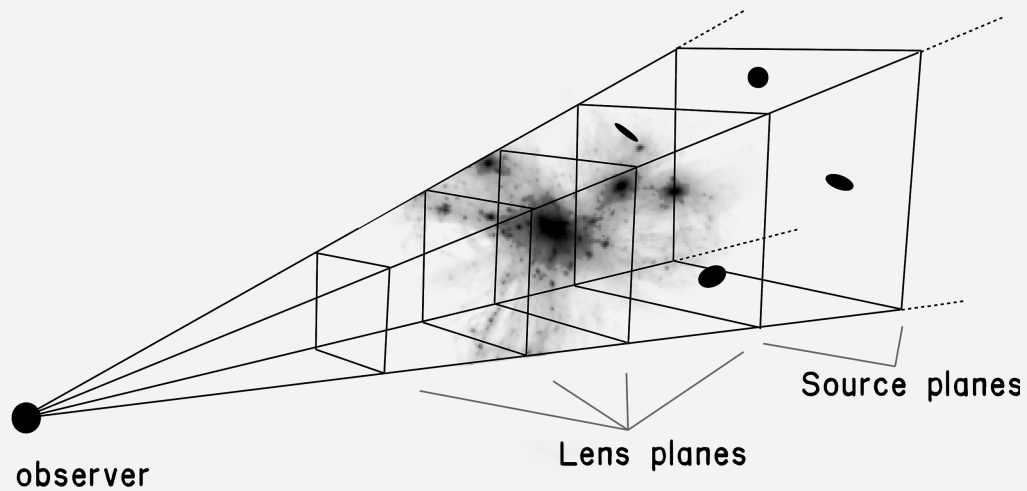
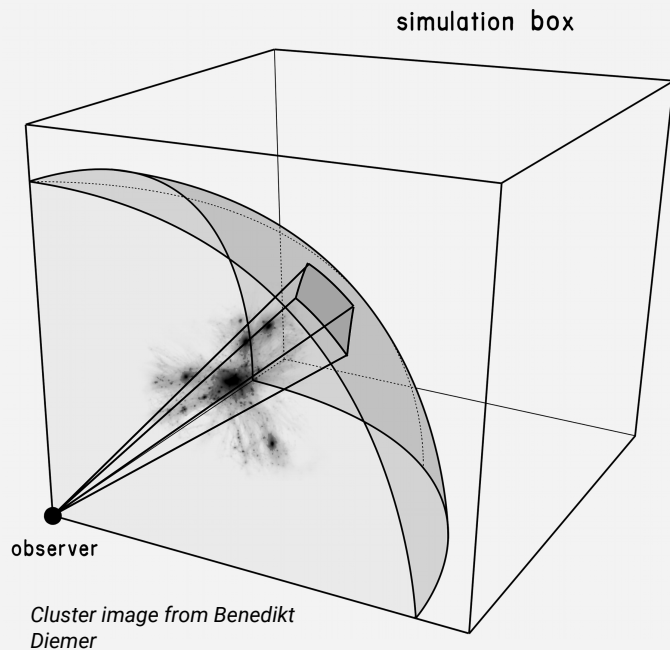
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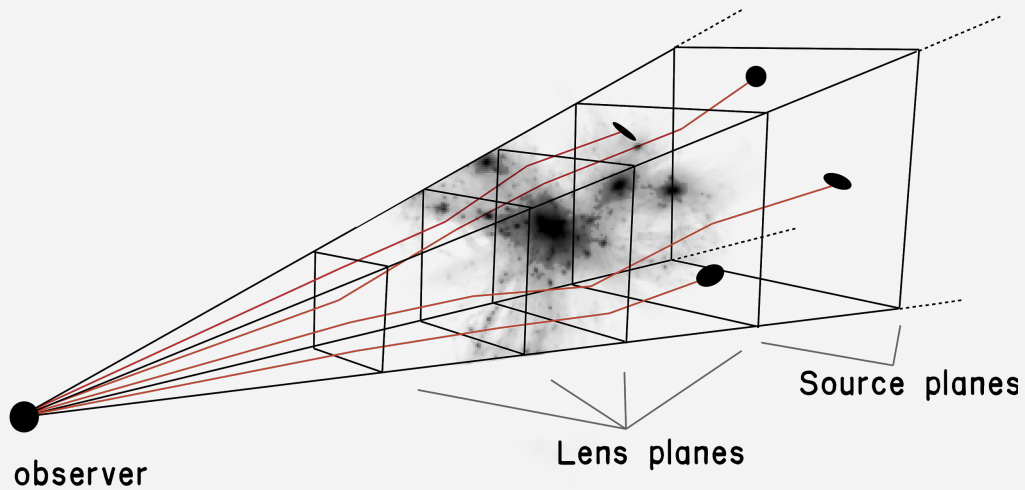
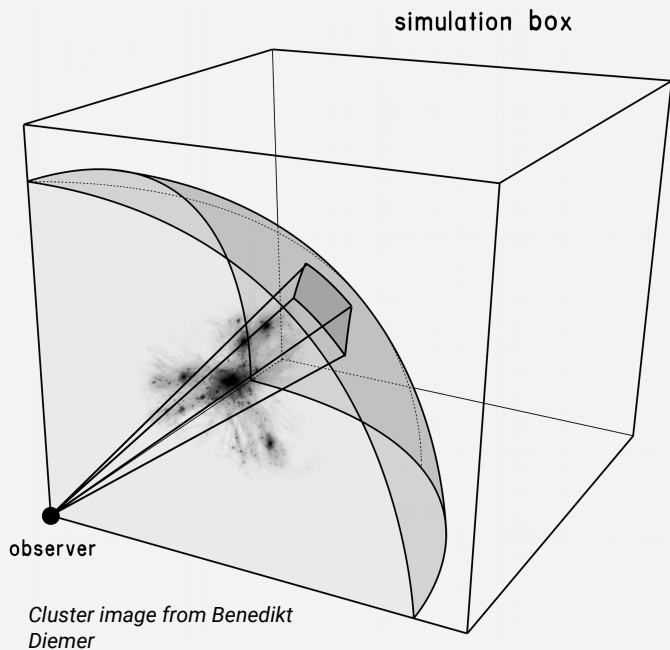
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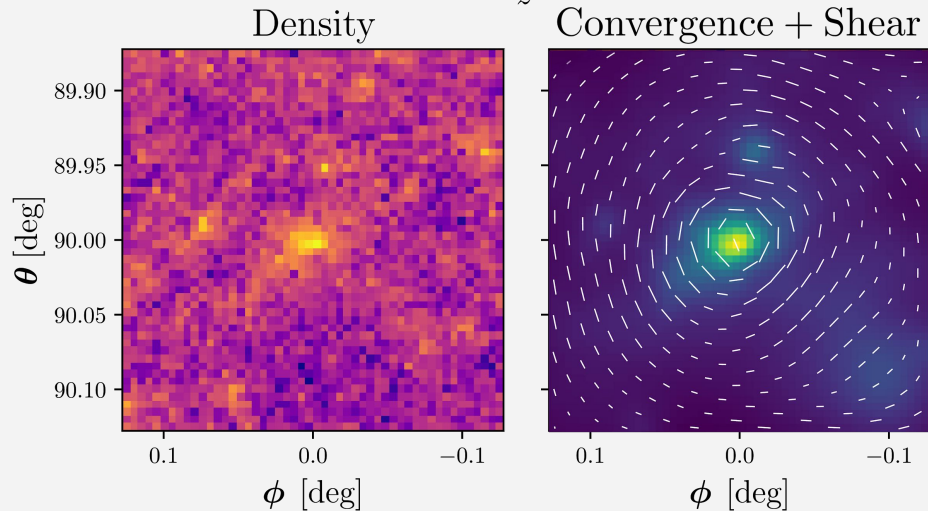
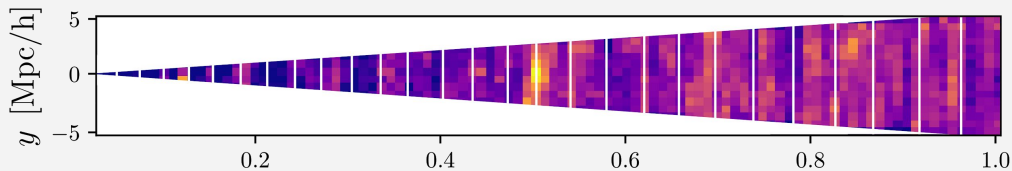


Lightcone Construction to Ray Tracing



Lightcone Construction to Ray Tracing





fov : $0.255 \times 0.255^\circ$

Halo Properties:

$z = 0.503$

mass = $2.703 \times 10^{14} M_\odot h^{-1}$

Ray Tracing:

Source plane at $z = 1$

28 lens planes from $0 \leq z \leq 1$

SPH particle smoothing

Base simulations:

AlphaQuadrant:

$256 (h^{-1} \text{Mpc})^3$
 1024^3 particles
 $1.1 \times 10^9 h^{-1} M_{\odot} \text{ mpp}$
WMAP-7

OuterRim:

$3000 (h^{-1} \text{Mpc})^3$
 10240^3 particles
 $1.8 \times 10^9 h^{-1} M_{\odot} \text{ mpp}$
WMAP-7

Lightcone products:

AlphaQuadrant:

1% particles to $z=3$
Full particles to $z=1$
Halos to $z=1$ ($\sim 30k > 10^{14}$)

OuterRim:

1% particles to $z=3$
Halos to $z=3$ ($> 100k > 10^{14}$)

Smaller simulation data more computationally affordable; will allow for convergence studies on ray-tracing strategy:

- ▶ LOS structure sampling?
- ▶ Density estimator?
- ▶ Pixelization for lensing maps?
- ▶ Cutout sizes?
- ▶ Redshift resolution (lens planes)?

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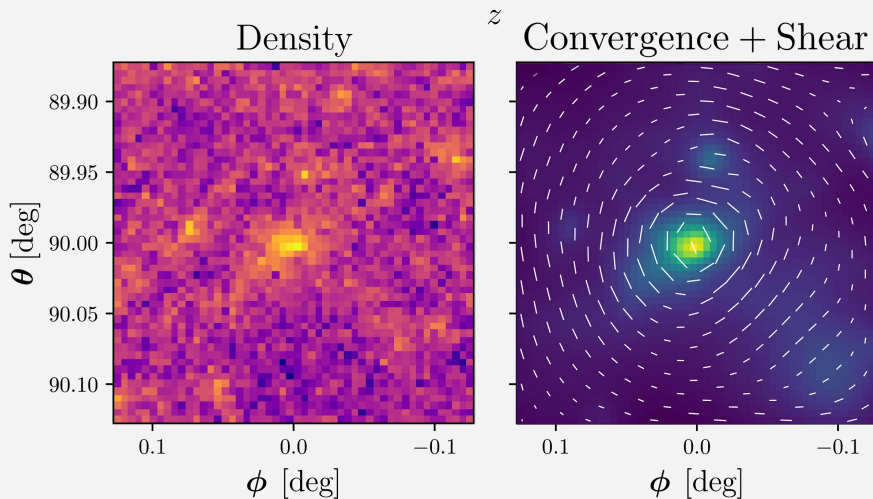
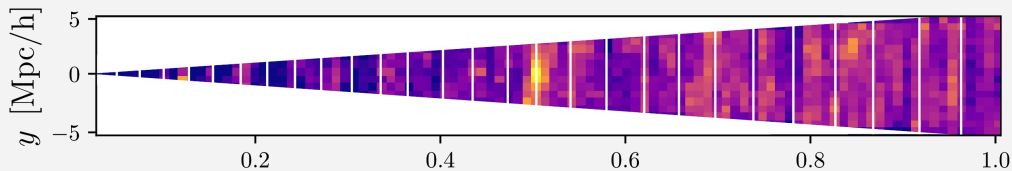
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Conclusions inform parameters for larger-scale runs (larger lightcone volume and more unique halos)

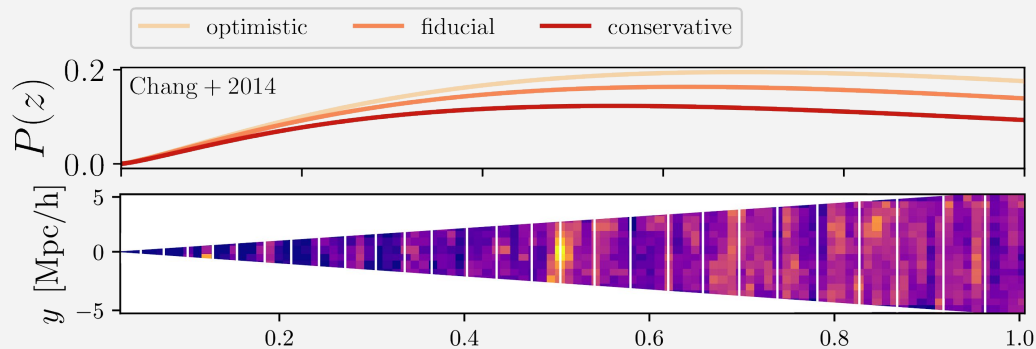


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Halo fitting systematics:

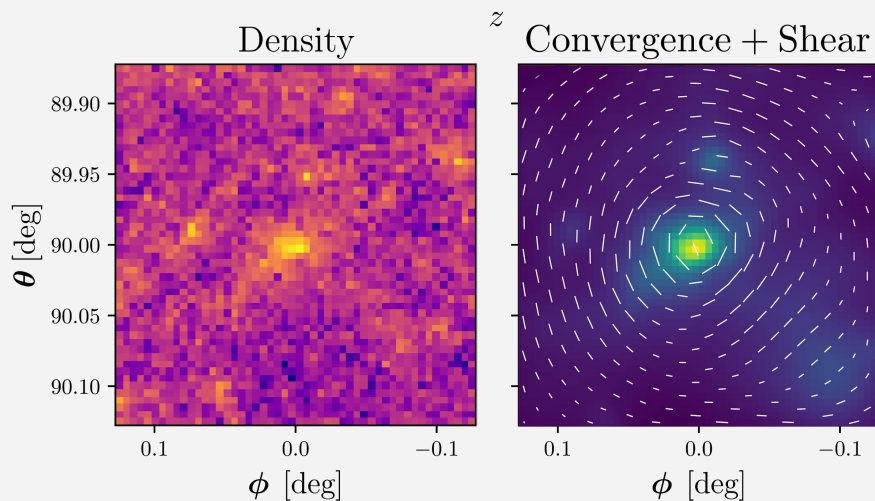
- Spherically symmetric density profile (NFW)
- Mass-concentration relation
- Correlated LSS
- Miscentering
- Cluster Selection

WL-Mass Reconstruction Systematics

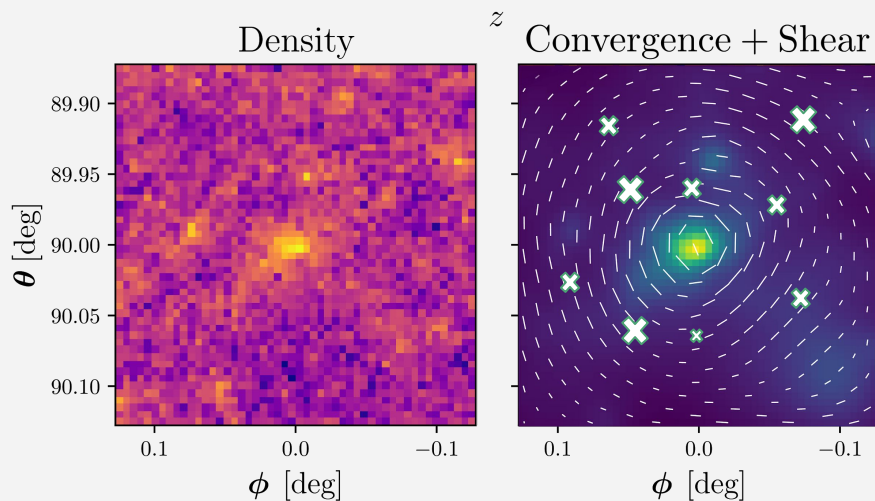
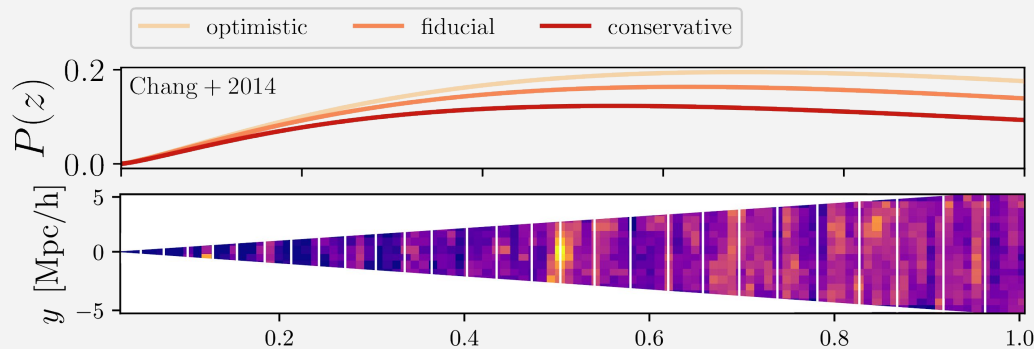


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Extend to DC2 - Lensing systematics:

- $\langle \beta \rangle$ and $\langle \beta^2 \rangle$ estimation
- Foreground Contamination
- PSF Correction
- Intrinsic Alignment
- etc...