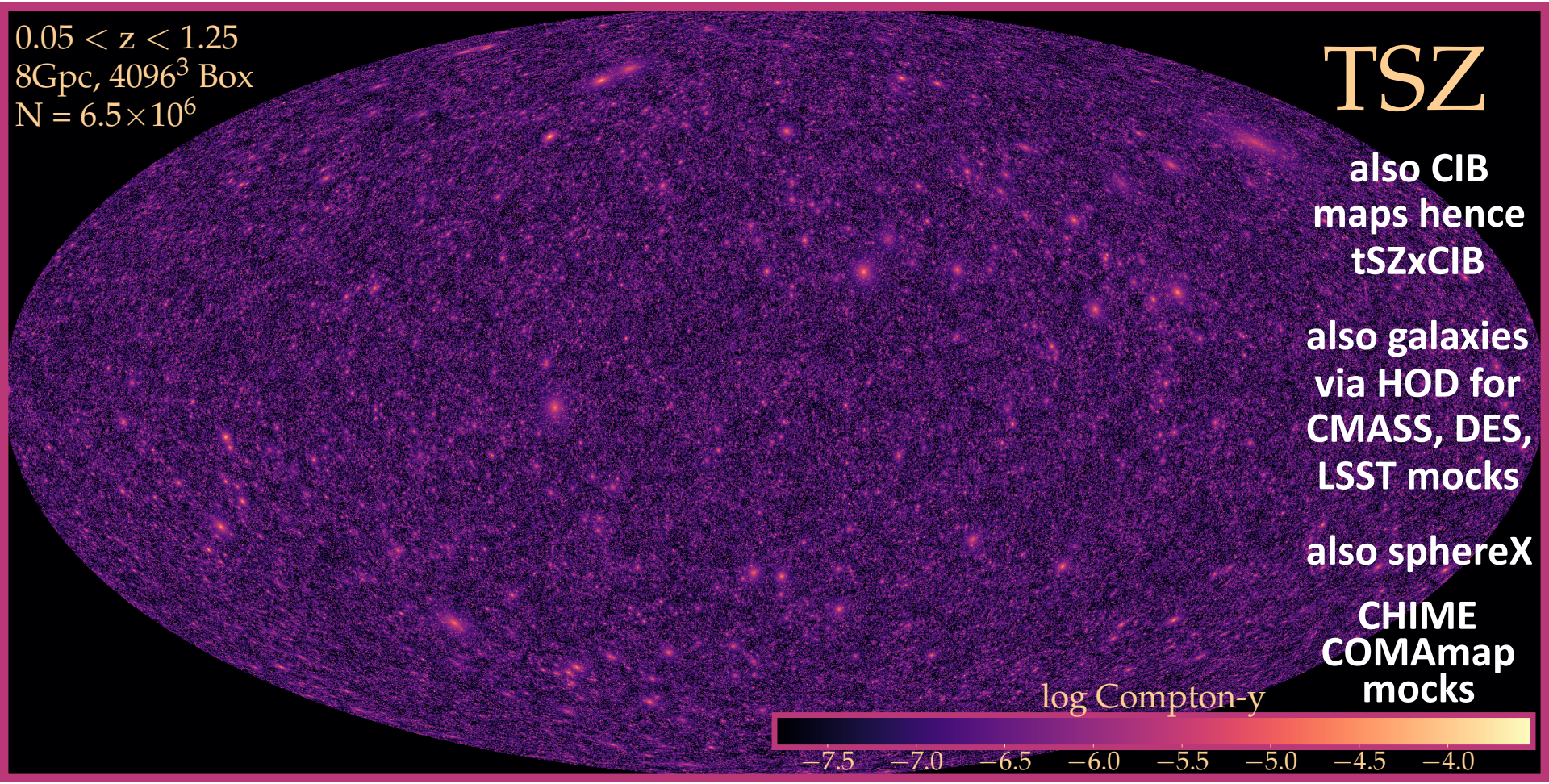
the **Cosmic Web of Clusters**, seen thru Compton cooling of high pressure electrons by the CMB via *peak patch sims*

Lightcone Simulation of Clusters > 1.0x10^{13} M_{sun} to z=1.3 in projected BBPS pressure

~10 minutes all-sky on 1024 cores on SciNet, aLatt=2Mpc, 500 sims ~83hrs => stats



SIMs to characterize inhomogeneous tSZ map errors (eg in Planck15 y-map)? scaled susceptibility of y to PV dN_cl - used BBPS, but key issue, measure in high res hydro sims, feedback dependent

CITA mini-industry

Alvarez, Bond,, Stein, Bahmanyer, Battaglia,,..2016

mocking heaven: ***fast all-sky Monte Carlo sims*** *accurate (?) which measure?*

$u_q(x)=\sum_c \chi_{qc}(x-x_c,R_{Ec})\, q_c \delta N_c(x_c,R_{Ec})+u_{qf}(x)u_{VE}+u_{qf}(x)(1-u_{VE})$

inside = $u_{VE}(x)$*, 1 or 0 outside =*$1-u_{VE}(x)$*=complement*

Eulerian *<=* ***Lagrangian*** *map: 1LPT* s_{Lc}*, 2LPT & beyond the art of* s_{NLc}

$x_c(t)=x_c(t_i)+s_{NLc}(t|x_c(t_i),t_i)$ $x_c(t_i)=r_c$ *initial Lagrangian position*

χ_{qc} ***susceptibility*** *of* u_q *to the "charge"* q_c *the art of halo models*

$q=M_{tot}, M_{dm}, M_{gas}, PV, V_E, K_{dm},..$

via measurement: hi res gas sims BBPS, n-body sims, observations

$M_c \sim R_{Lc}^3$, R_{Ec}, BE_c *from the peak patch algorithm*

"mocking heaven" apps: **tSZ, CIB original motivation => tSZxCIB**

τ_c , kSZ

optical galaxies **via HOD for CMASS, DES, HSC, LSST, .. sphereX**

"intensity mapping" **of HI (CHIME, HIREX, ..,SKA) of CO COMAmap**

well suited: **to cross-correlation studies of all sorts**

well suited: **to characterize correlated and non-Gaussian errors**

Physics: *beyond Lambda:* dynamical DE, modified gravity

LSS *non-Gaussianity:* perturbative, intermittent, scale-dependent bias

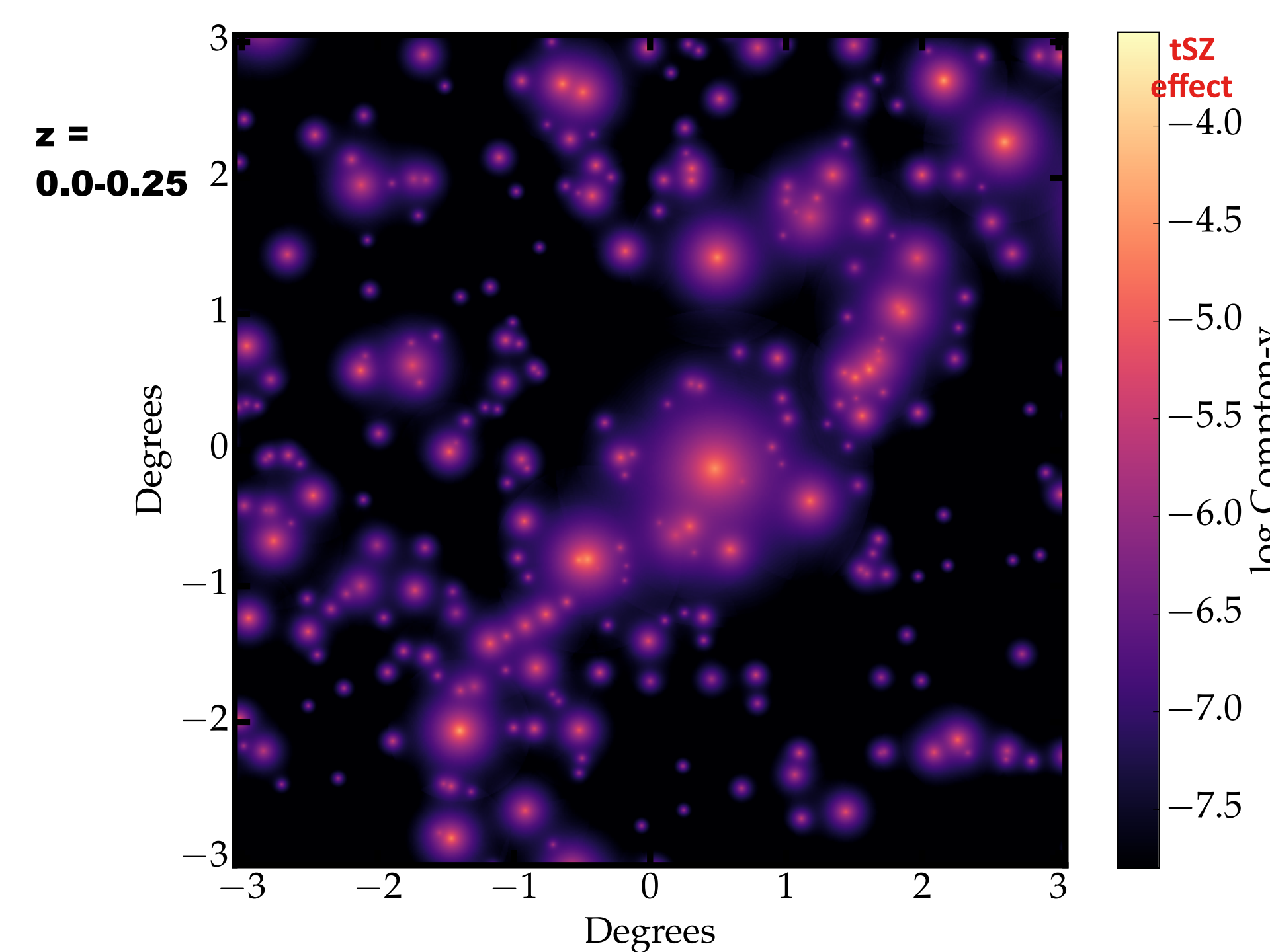
collapse fraction $u_M(r)=u_{VL}=\rho_{Lcoll}/\rho_{m0}=\sum_c \Theta_c(r-r_c,R_{Lc})\,\delta N_c(r_c,R_{Lc})$
evolves to $\rho_{Ecoll}/\rho_{m0}=\sum_c \chi_{Mc}(x-x_c,R_{Ec})\,M_c\,\delta N_c(x_c,R_{Ec})$ NFWish χ_{Mc}
Eulerian collapse fraction $u_{VE}(x)=\sum_c \Theta_c(x-x_c,R_{Ec})\,\delta N_c(x_c,R_{Ec})$

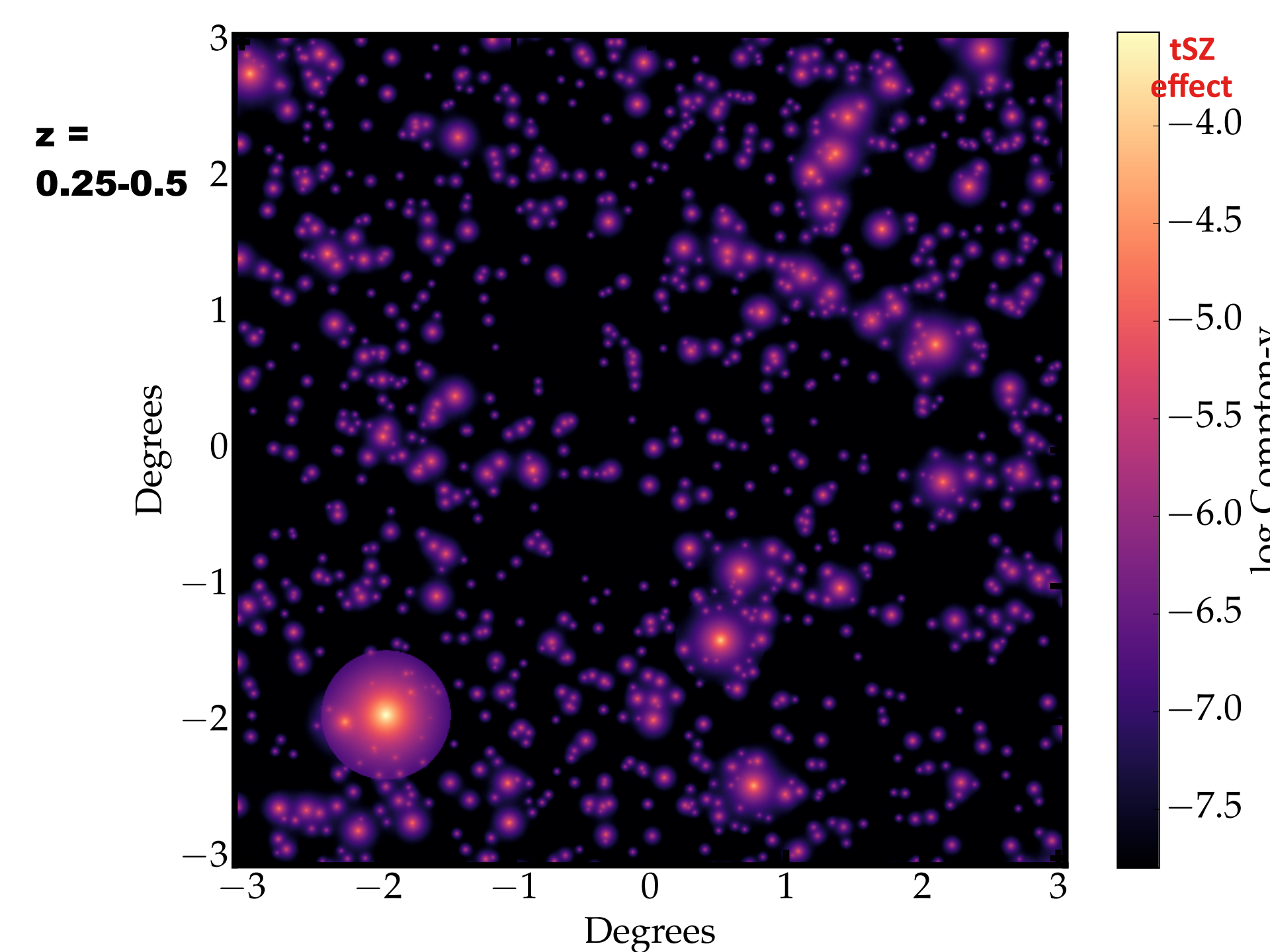
some advantages over "analytic" halo models:

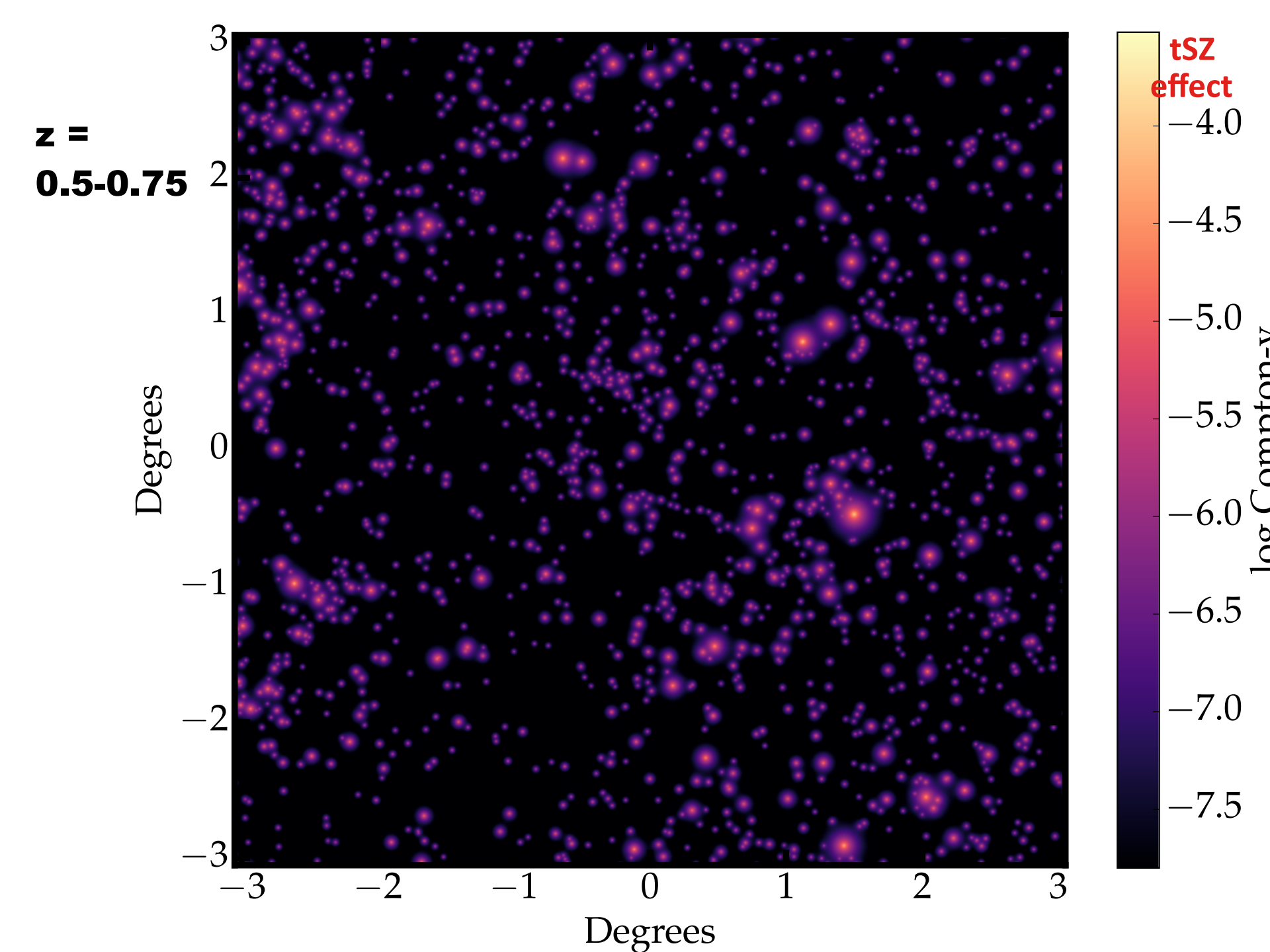
2-halo exclusion; 2-halo nonlinearity
assembly bias dependence on 2nd, 3rd, …, parameters
$\xi(x|M1,M2)$, P(D) & other non-Gaussian statistics
oriented correlations, filamentary web

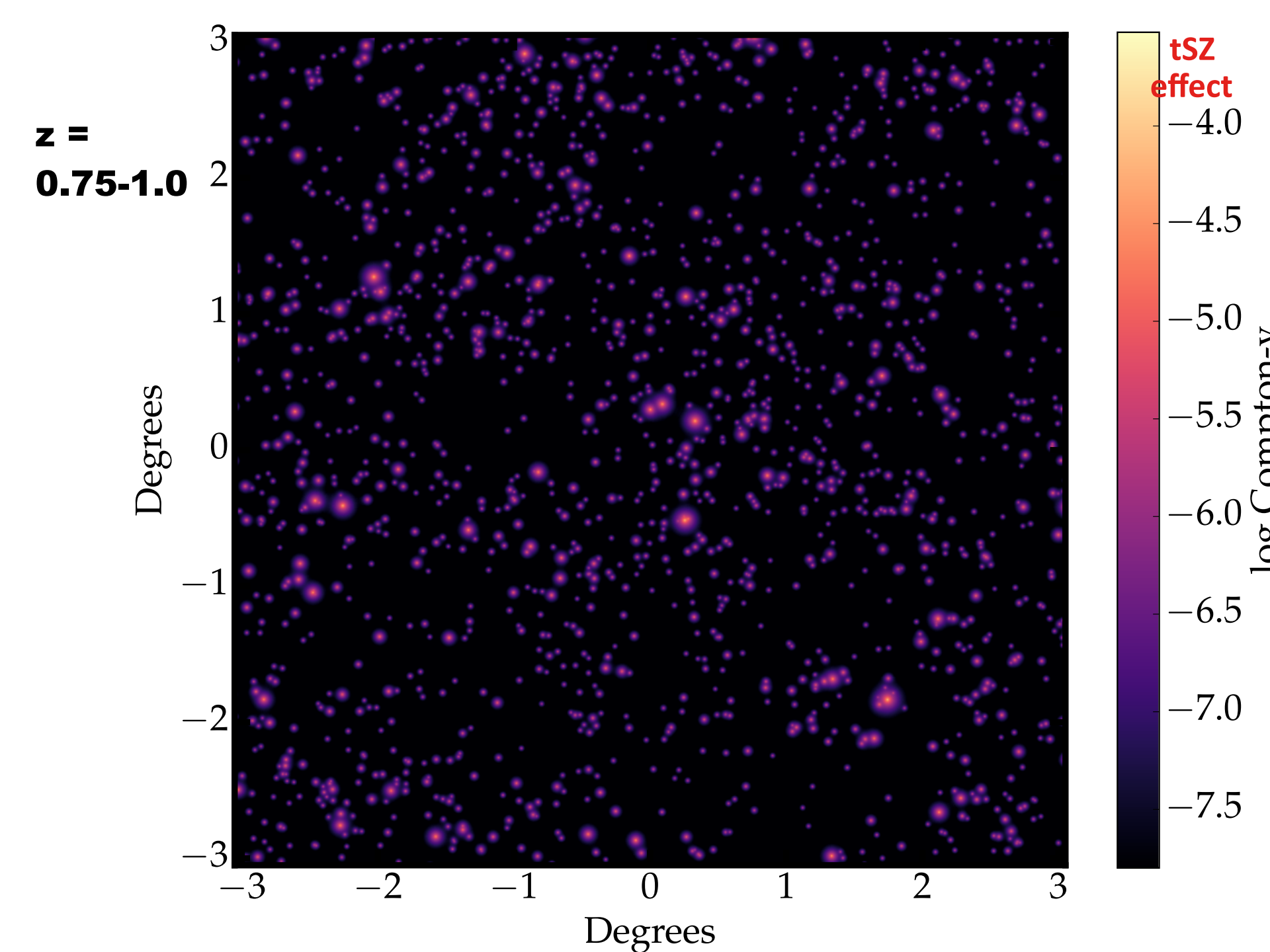
ToBeDone for 'PeakPatches': => Potential-pit Patches

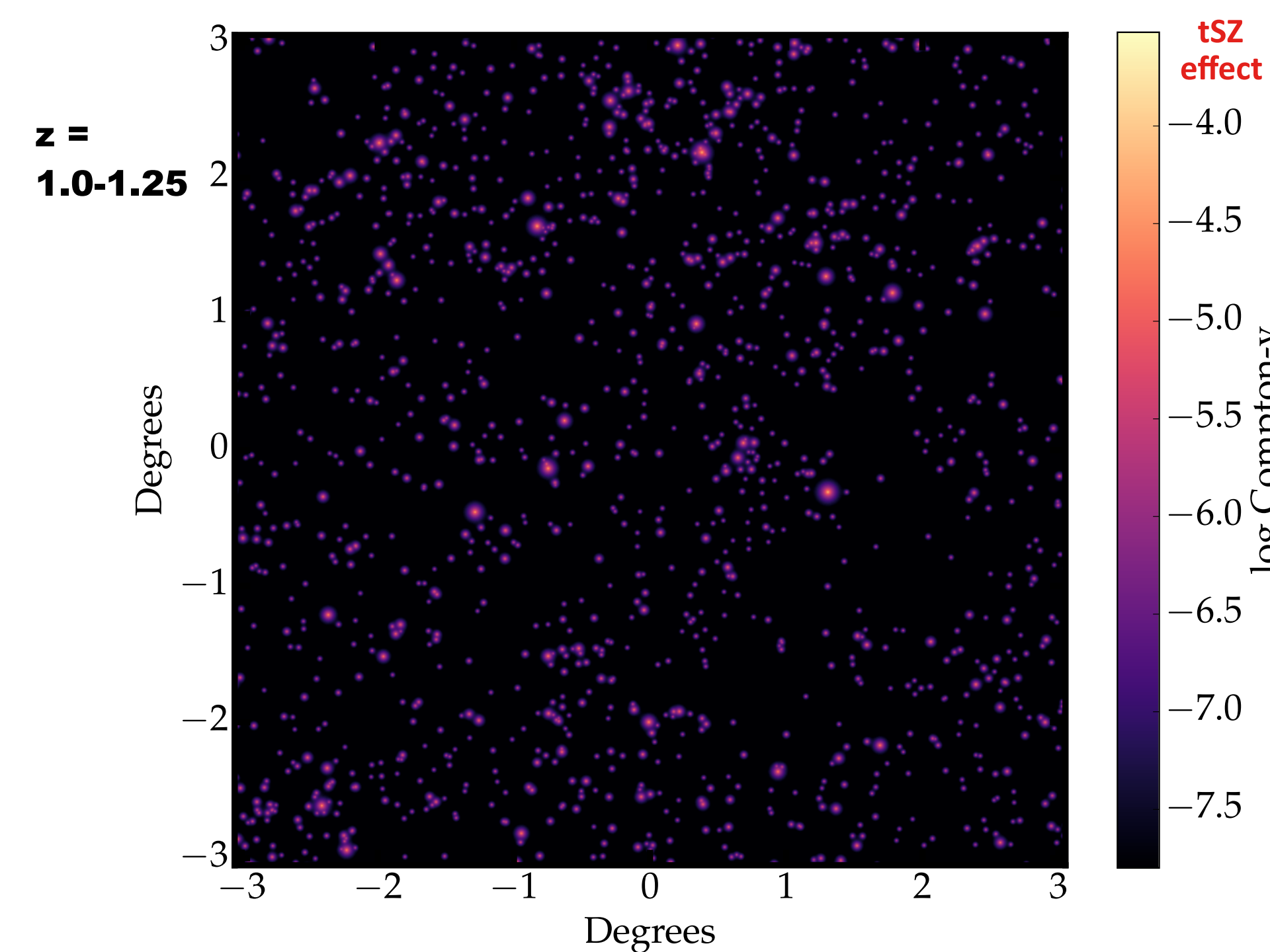
"subgrid" halos nonlinear bias + exclusion - underway
exterior fluctuations (weak lensing) - (good?) ideas
interior fluctuations (subclumping, subhalos, $\delta p,\delta\rho$)
measurement in hi res sims, some in BBPS
3 point function testing beyond 2LPT


z =
0.0-0.25
tSZ
effect
Degrees
Degrees
log Compton-y
3
2
1
0
−1
−2
−3
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5


z =
0.25-0.5
tSZ
effect
Degrees
Degrees
log Compton-y
3
2
1
0
−1
−2
−3
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5


z =
0.5-0.75
tSZ
effect
3
2
1
0
−1
−2
−3
Degrees
−3
−2
−1
0
1
2
3
Degrees
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5
log Compton-y


z =
0.75-1.0
tSZ
effect
Degrees
Degrees
log Compton-y
3
2
1
0
−1
−2
−3
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5


z =
1.0-1.25
tSZ
effect
3
2
1
0
−1
−2
−3
Degrees
−3
−2
−1
0
1
2
3
Degrees
−4.0
−4.5
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5
log Compton-y

the **Cosmic Web of Clusters**, seen thru optical surveys

such as CMASS via *peak patch sims*

Lightcone Simulation of Clusters > 1.0x10^{13} M$_{sun}$ to z=1.3 in projected BBPS pressure

~10 minutes all-sky on 1024 cores on SciNet, aLatt=2Mpc, 500 sims ~83hrs

here adopt CMASS simulation parameters of Manera (PThalos), but many more sims, fast, nonGaussian. easy to apply to DESI, HSC, LSST,

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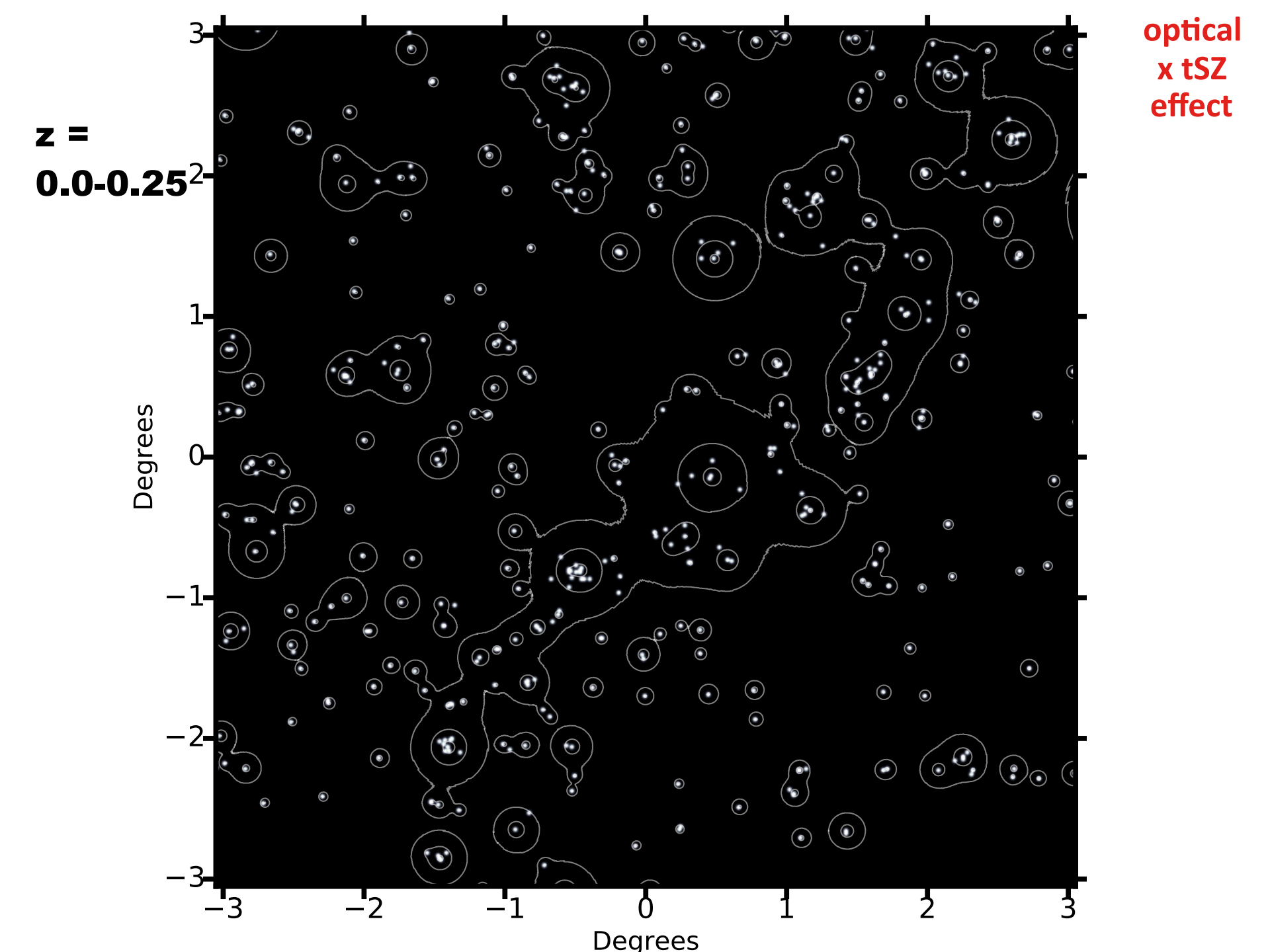
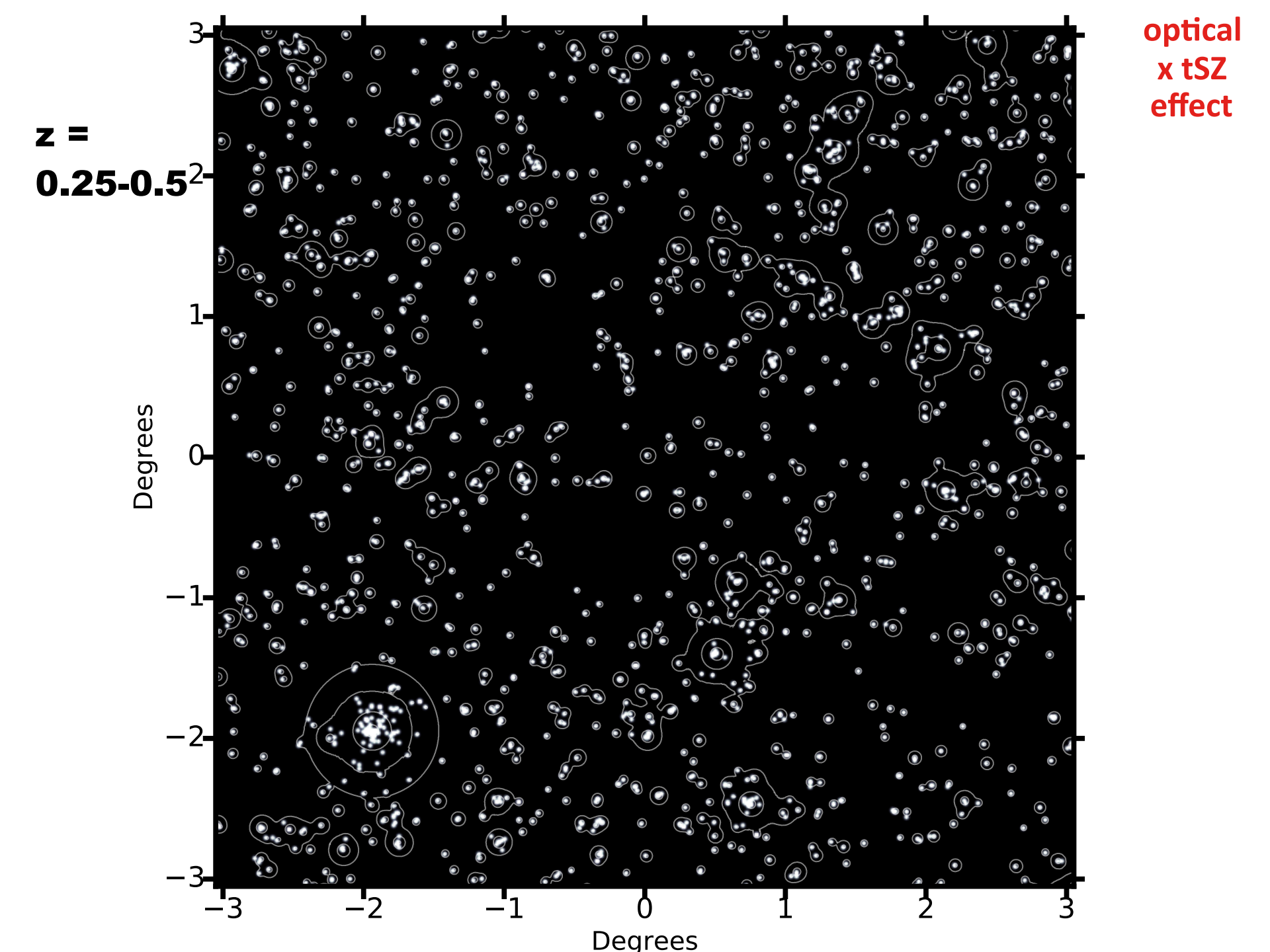
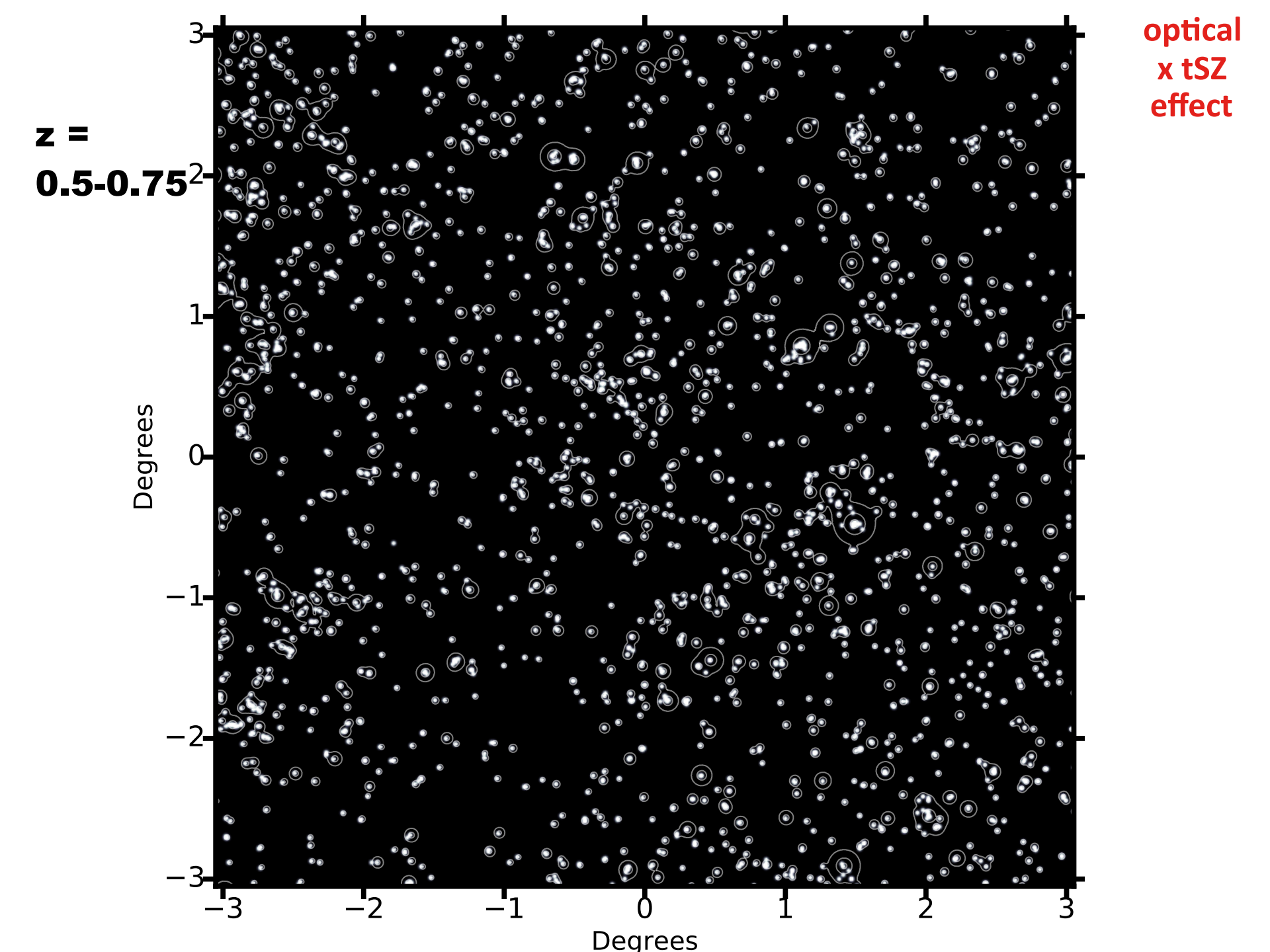
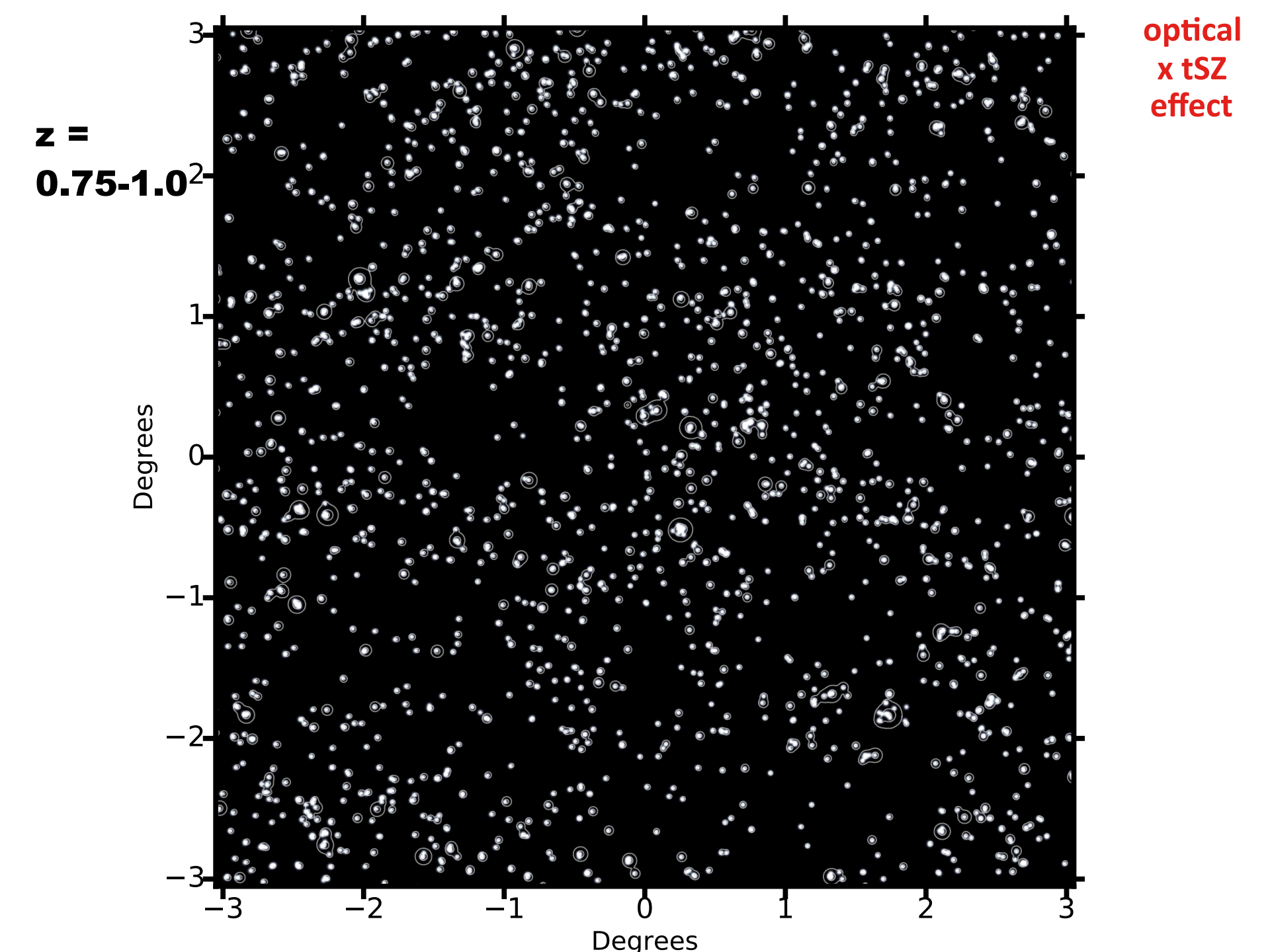
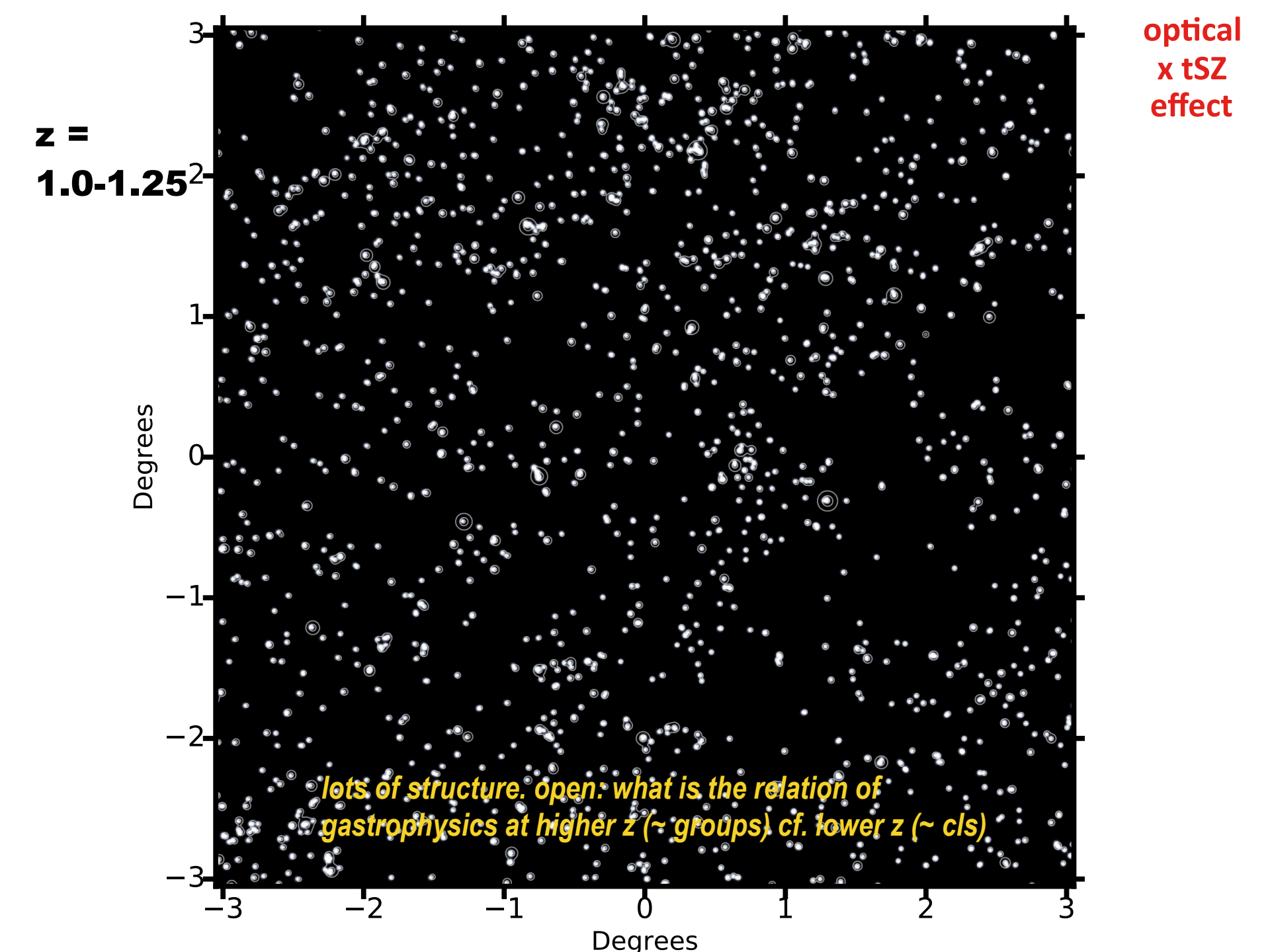
Alvarez, Bond,, Stein, Bahmanyer, Battaglia,,..2016


z =
0.0-0.25
optical
x tSZ
effect
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3


z =
0.25-0.5
optical
x tSZ
effect
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3


z =
0.5-0.75
optical
x tSZ
effect
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3

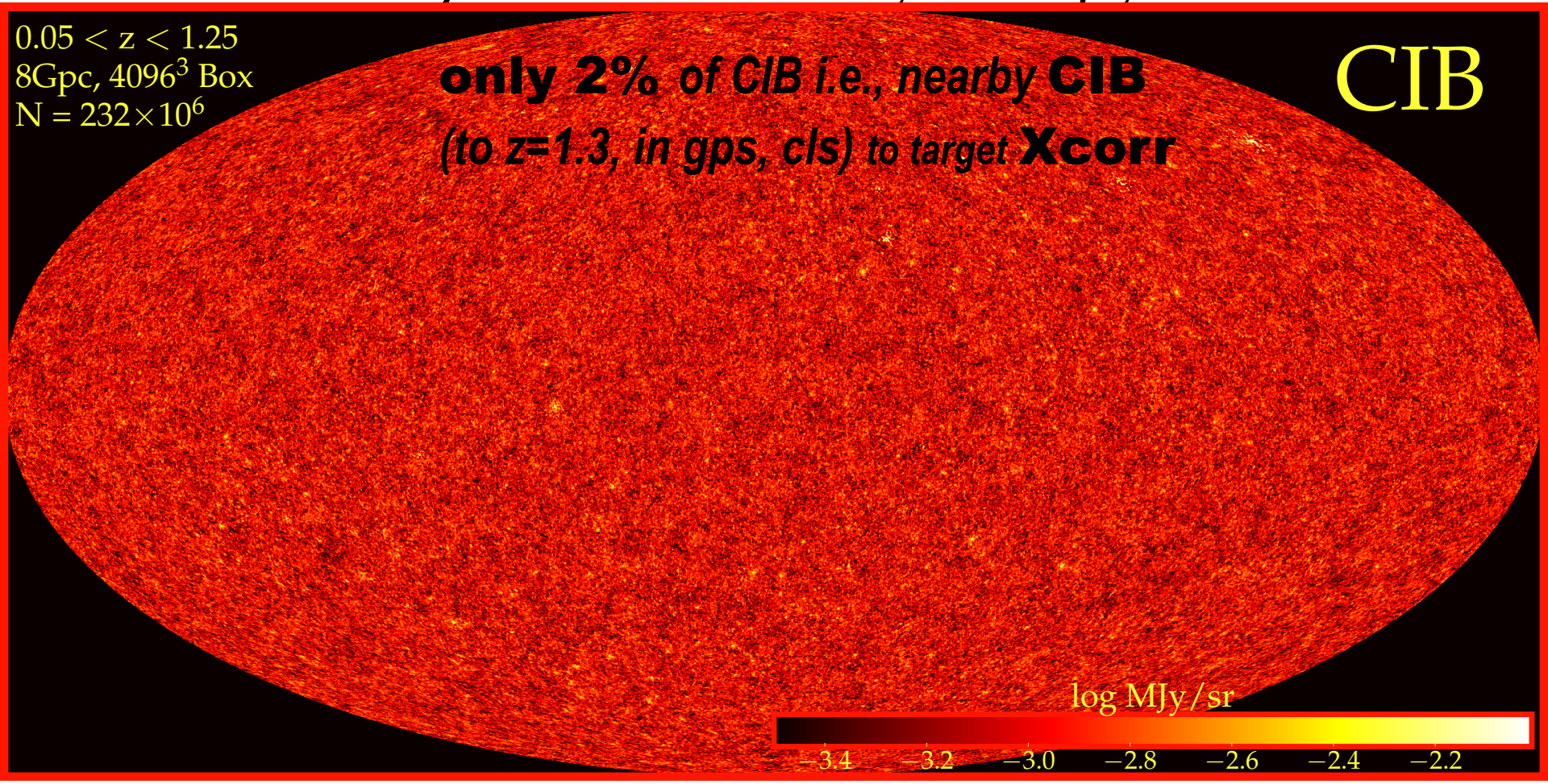

z =
0.75-1.0
optical
x tSZ
effect
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3


optical
x tSZ
effect
z =
1.0-1.25
3
2
1
0
−1
−2
−3
Degrees
−3
−2
−1
0
1
2
3
Degrees
lots of structure. open: what is the relation of
gastrophysics at higher z (~ groups) cf. lower z (~ cls)

the **Cosmic Web of Clusters**, seen thru the Cosmic Infrared Background via *peak patch sims*

Lightcone Simulation of Clusters > 1.0×10^{13} M_{sun} to z=1.3 in projected BBPS pressure

~10 minutes all-sky on 1024 cores on SciNet, aLatt=2Mpc, 500 sims ~83hrs



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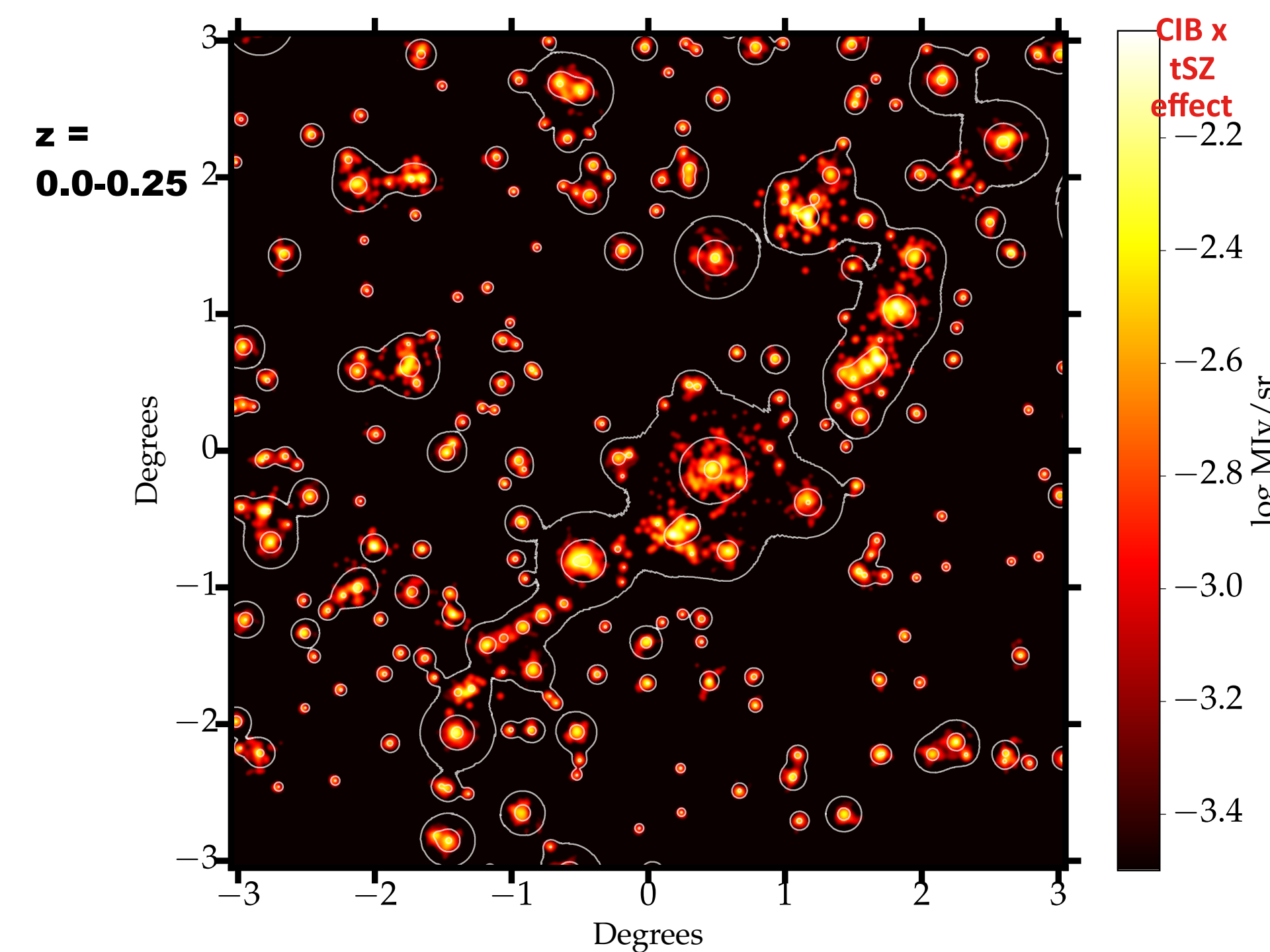
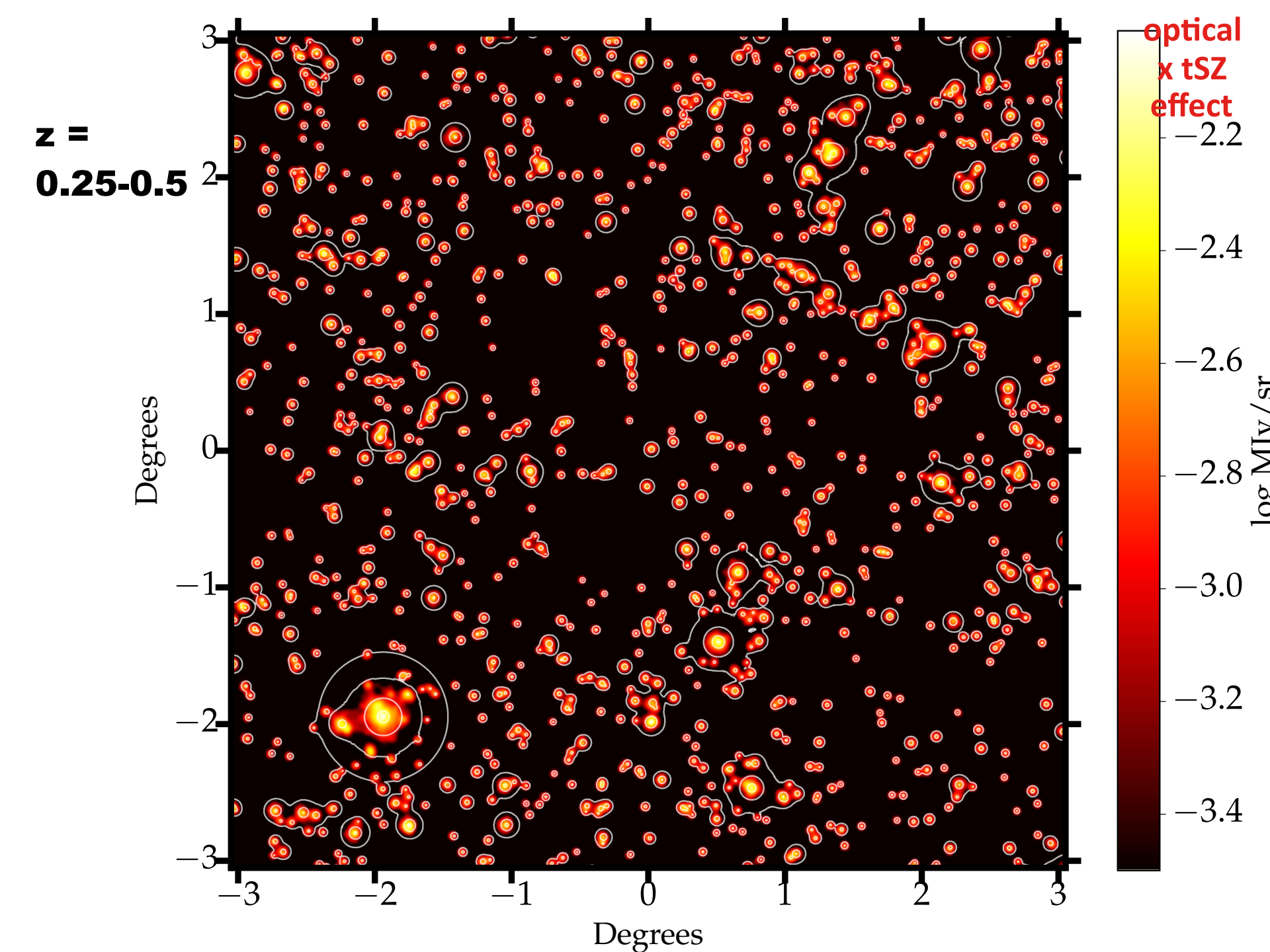
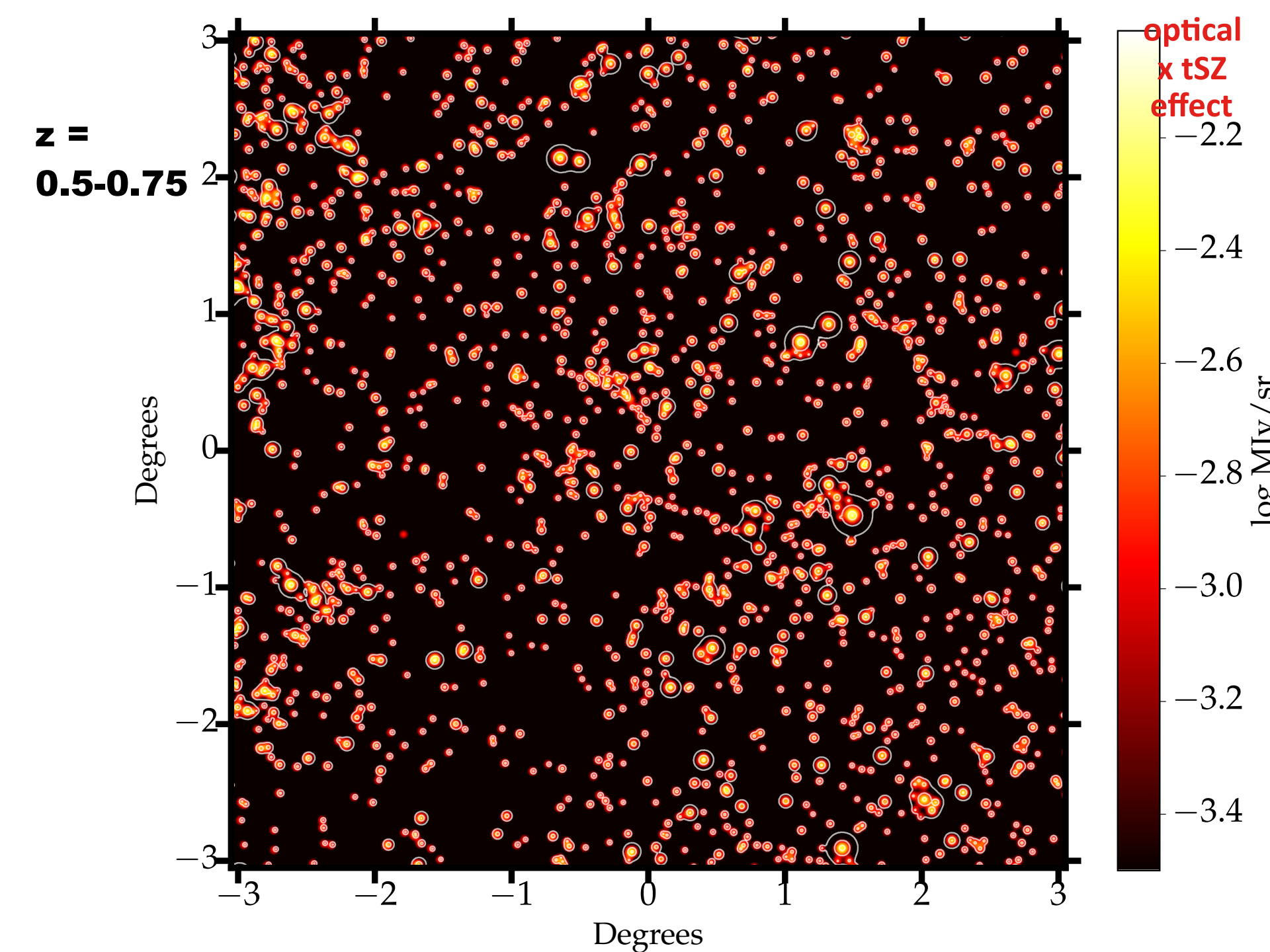
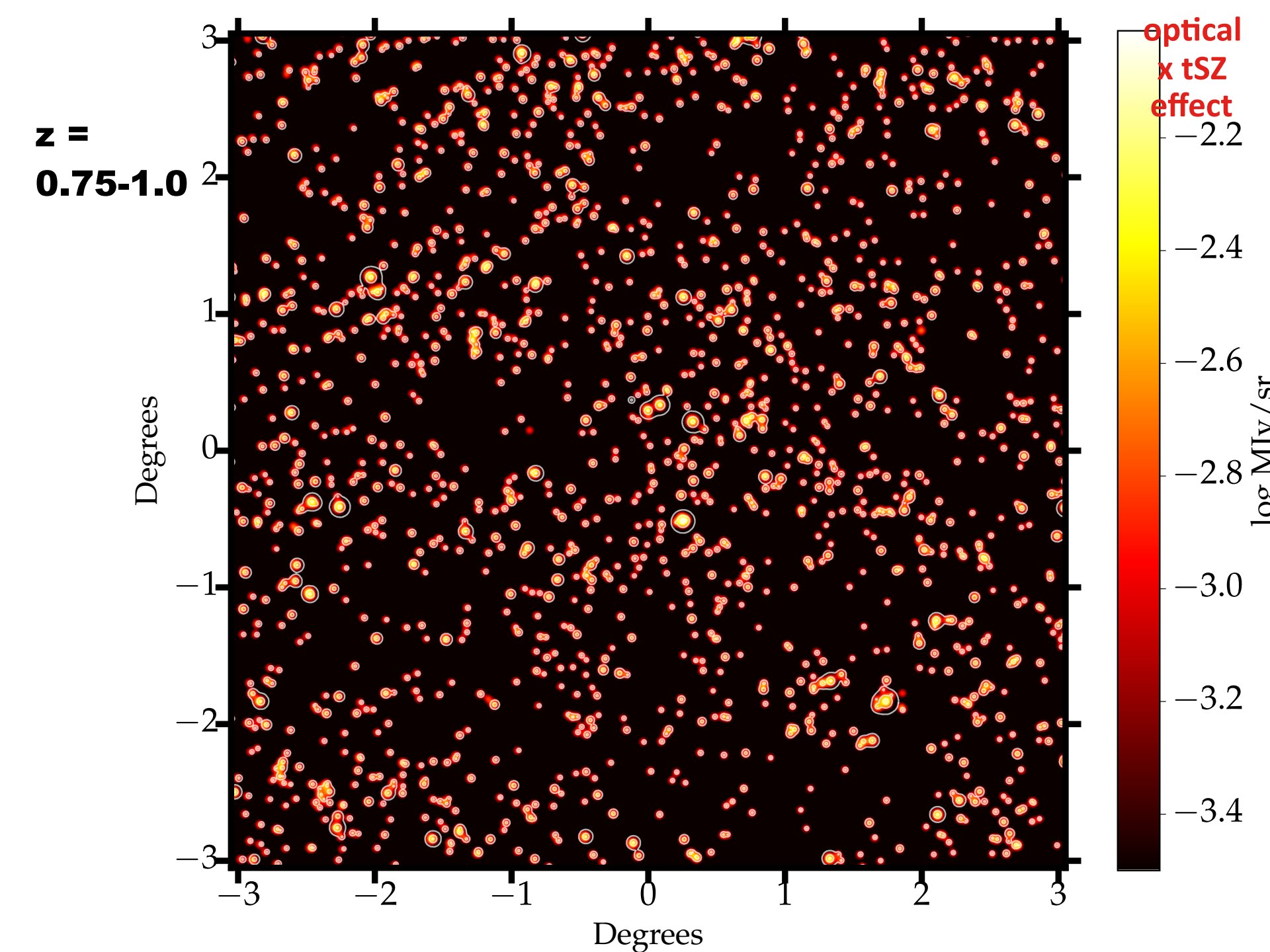
Alvarez, Bond,, Stein, Bahmanyer, Battaglia,,..2016

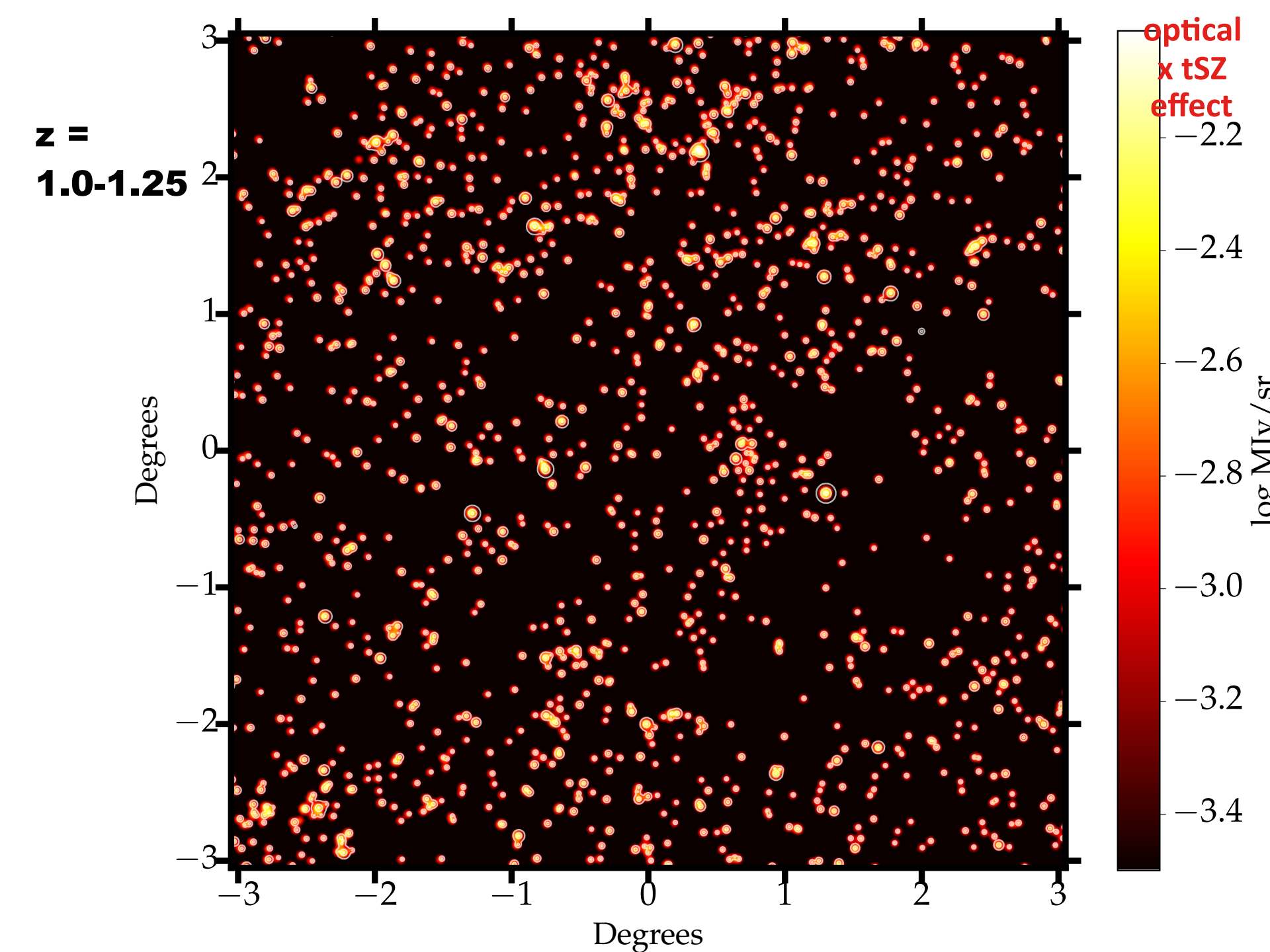
CIB modelling - use Planck 2015 CIB model, Shang+ 2012, Bettermin, but all quite uncertain. e.g., intermittency, cluster suppression, star bursting, etc.


z =
0.0-0.25
CIB x
tSZ
effect
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4
log MJy/sr
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3


z =
0.25-0.5
optical
x tSZ
effect
Degrees
Degrees
log MJy/sr
3
2
1
0
−1
−2
−3
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4


z =
0.5-0.75
optical
x tSZ
effect
Degrees
Degrees
log MJy/sr
3
2
1
0
−1
−2
−3
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4


z =
0.75-1.0
optical
x tSZ
effect
Degrees
Degrees
log MJy/sr
3
2
1
0
−1
−2
−3
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4


z =
1.0-1.25
optical
x tSZ
effect
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4
log MJy/sr
Degrees
Degrees
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3

usefulness of the pk patch simulation method for mocking AdvACT?

y-map, kSZ, lens, .. applications

non-G C_L^{SZ} error statistics

1,2,…N-point distributions in maps BM93/96

cross-correlations Xray-tSZ, Lens-tSZ, BCG-tSZ, CIB-tSZ, ..

END