Using Real and Simulated Measurements of the Thermal Sunyaev-Zel'dovich Effect to Constrain Models of AGN Feedback

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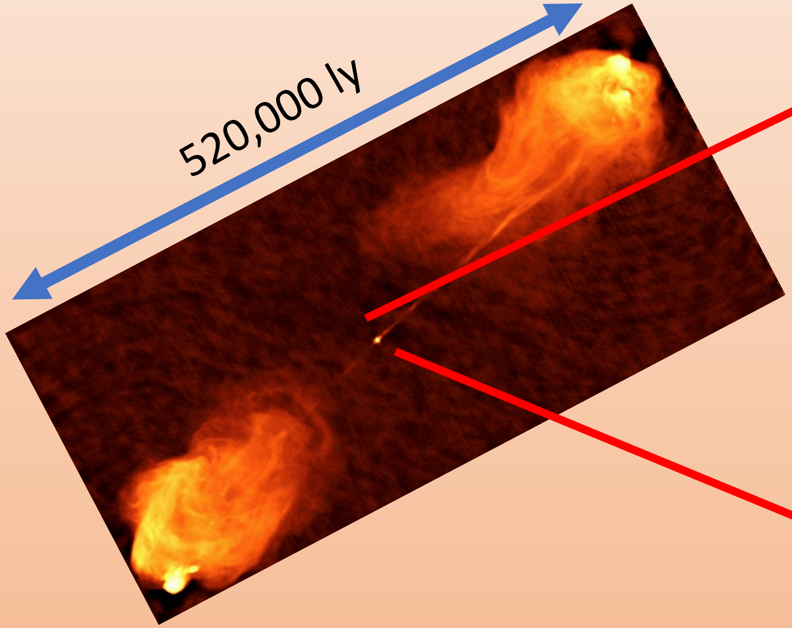
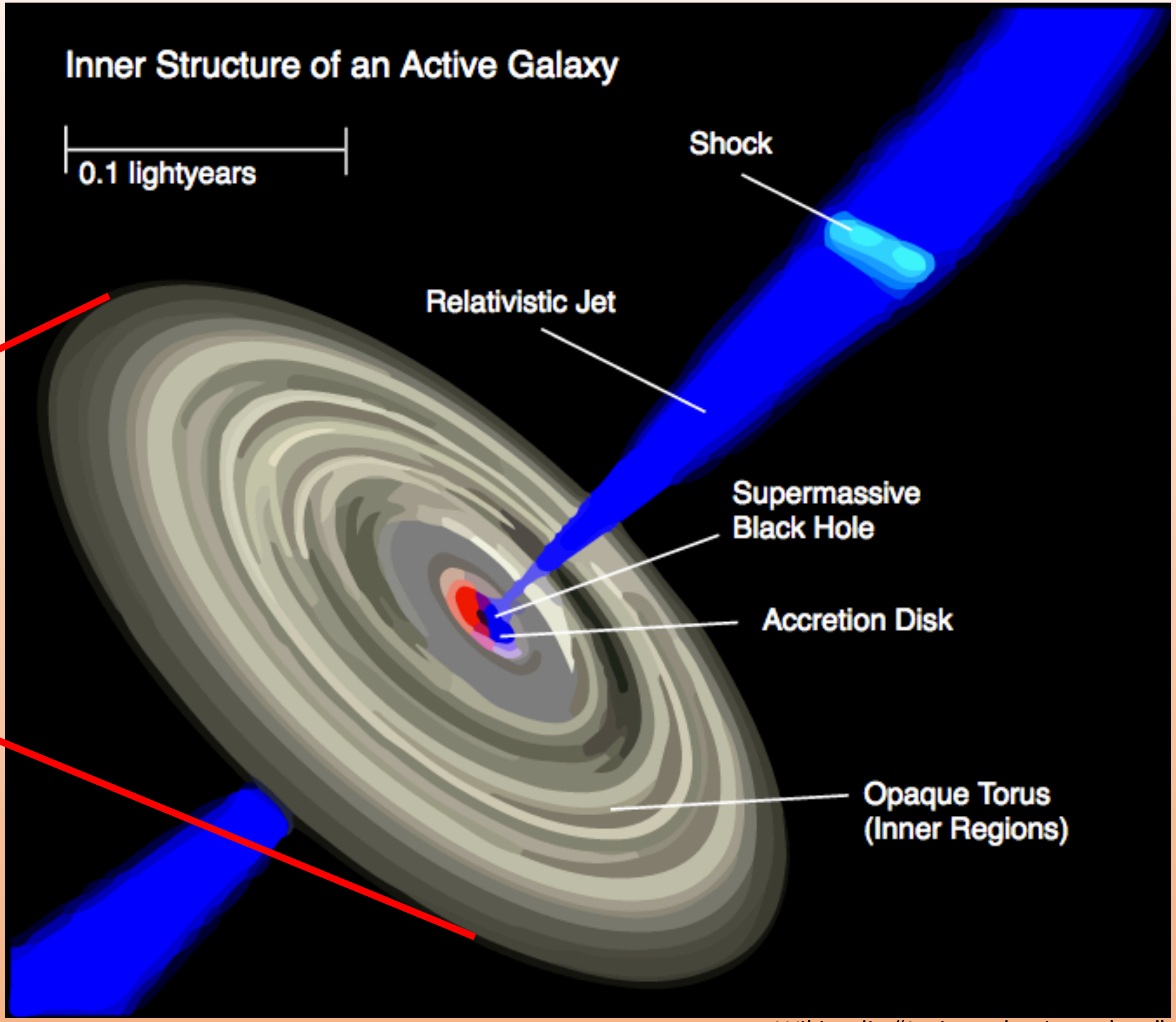
AGN Feedback

Active galactic nucleus (AGN):





Cygnus A (NRAO/AUI)

Wikipedia "Active galactic nucleus"

Why Investigate AGN Feedback?

- **Penny et al. 2017 – Oct 20** – arXiv:1710.07568 [astro-ph.GA]

  SDSS-IV MaNGA: Evidence of the **importance of AGN feedback in low-mass galaxies**

- **Lim et al. 2017 – Oct 18** – arXiv:1710.06856 [astro-ph.GA]

  Hot gas content in galaxy groups in **good agreement with simulations that include AGN feedback**, rather than just supernova feedback.

- **Dashyan et al. 2017 – Oct 16** – arXiv:1710.05900 [astro-ph.GA]

  Observed dwarf galaxy properties possibly **explained more successfully by negative AGN feedback** than by supernova feedback.

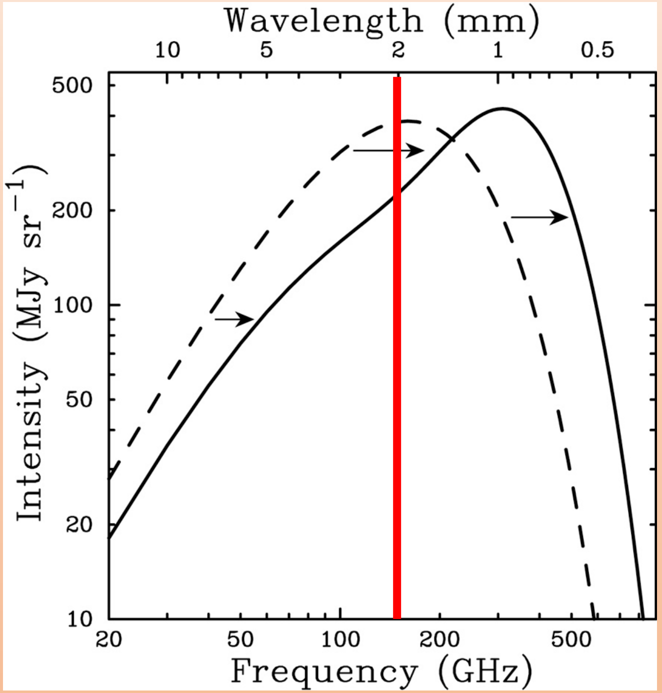
- **Weinberger et al. 2017 – Oct 12** – arXiv:1710.04659 [astro-ph.GA]

  IllustrisTNG simulation: stellar feedback dominates at high redshift, thermal AGN feedback then dominates inefficiently, with **kinetic AGN feedback important in massive galaxies at late times**.

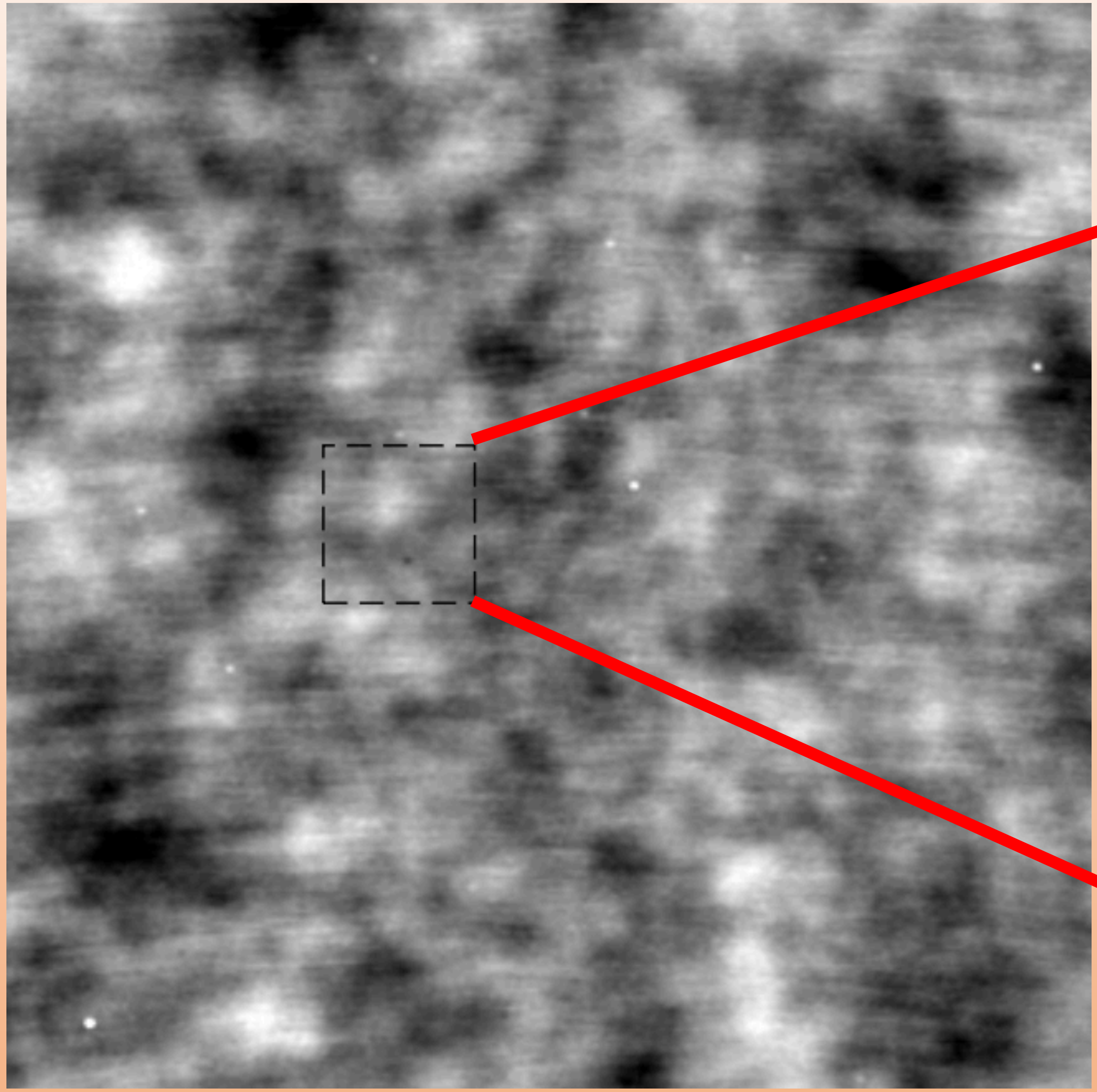
- **Nevin et al. 2017 – Oct 2** – arXiv:1710.00828 [astro-ph.GA]

  Looked at 18 galaxies with outflows and tentatively find that the **galaxies are quenched and possibly experiencing negative AGN feedback**.

The tSZ Effect

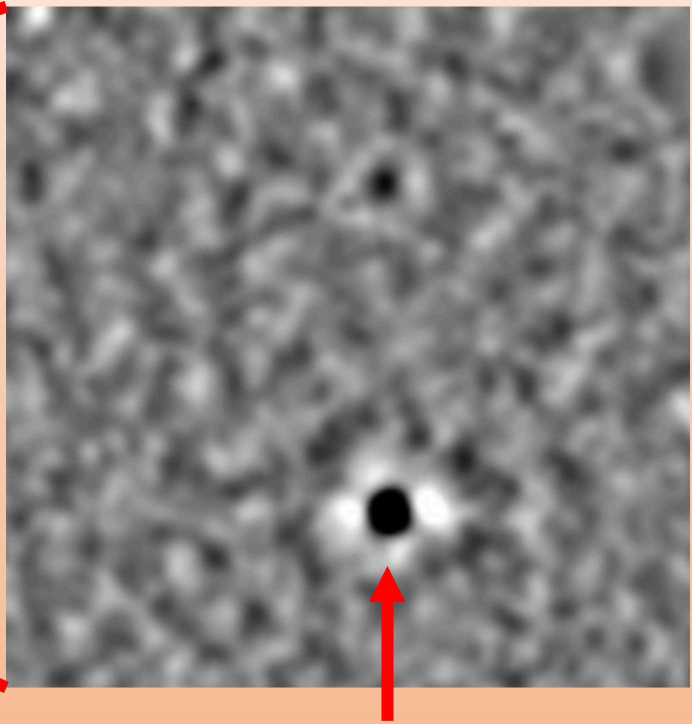


Carlstrom et al. 2002



SPT 150 GHz – 6 x 6 deg

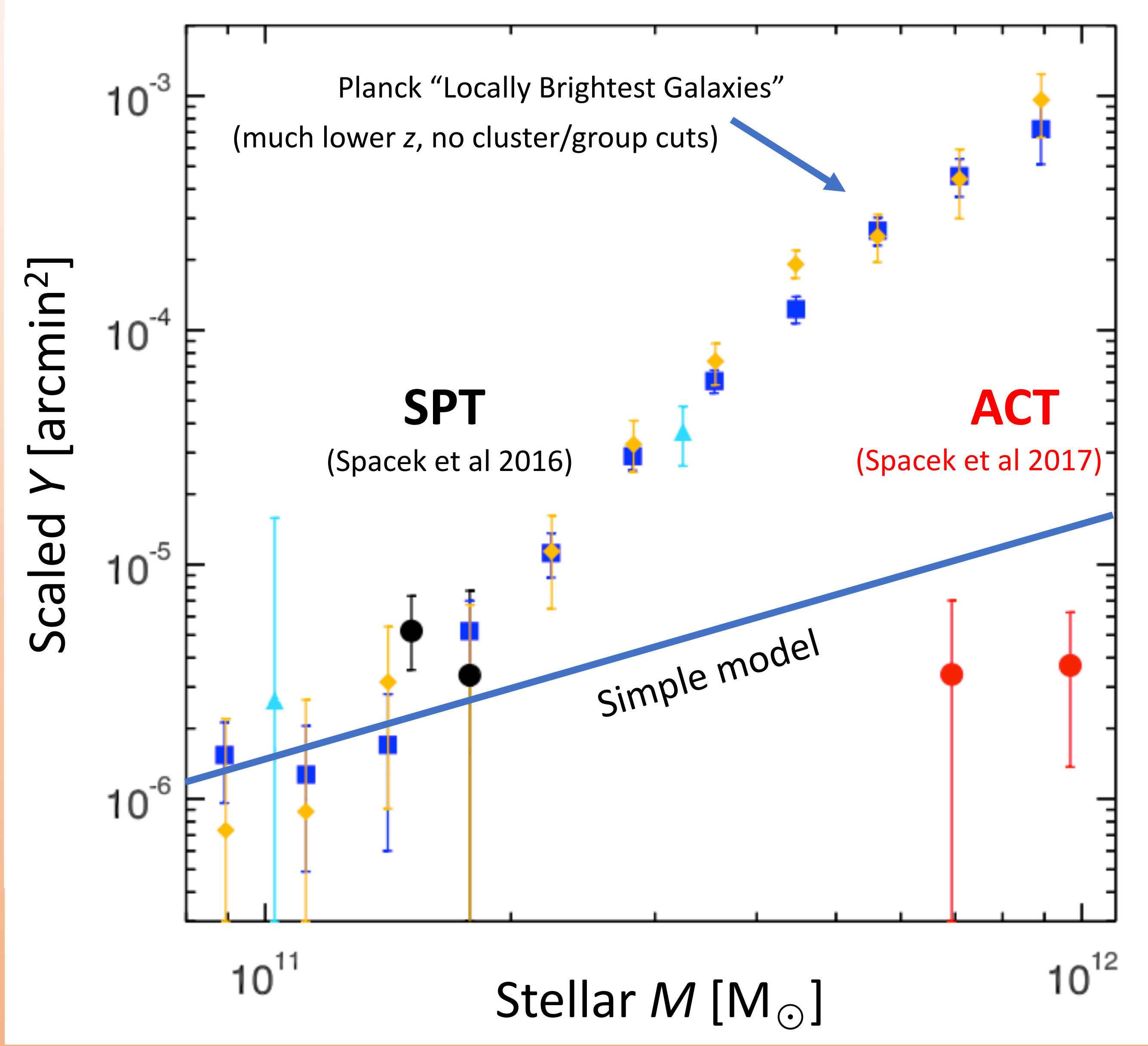
Zoom – 1 x 1 deg



Massive galaxy cluster
Large tSZ decrement

Bleem et al. 2015

The Real Measurements: SPT and ACT



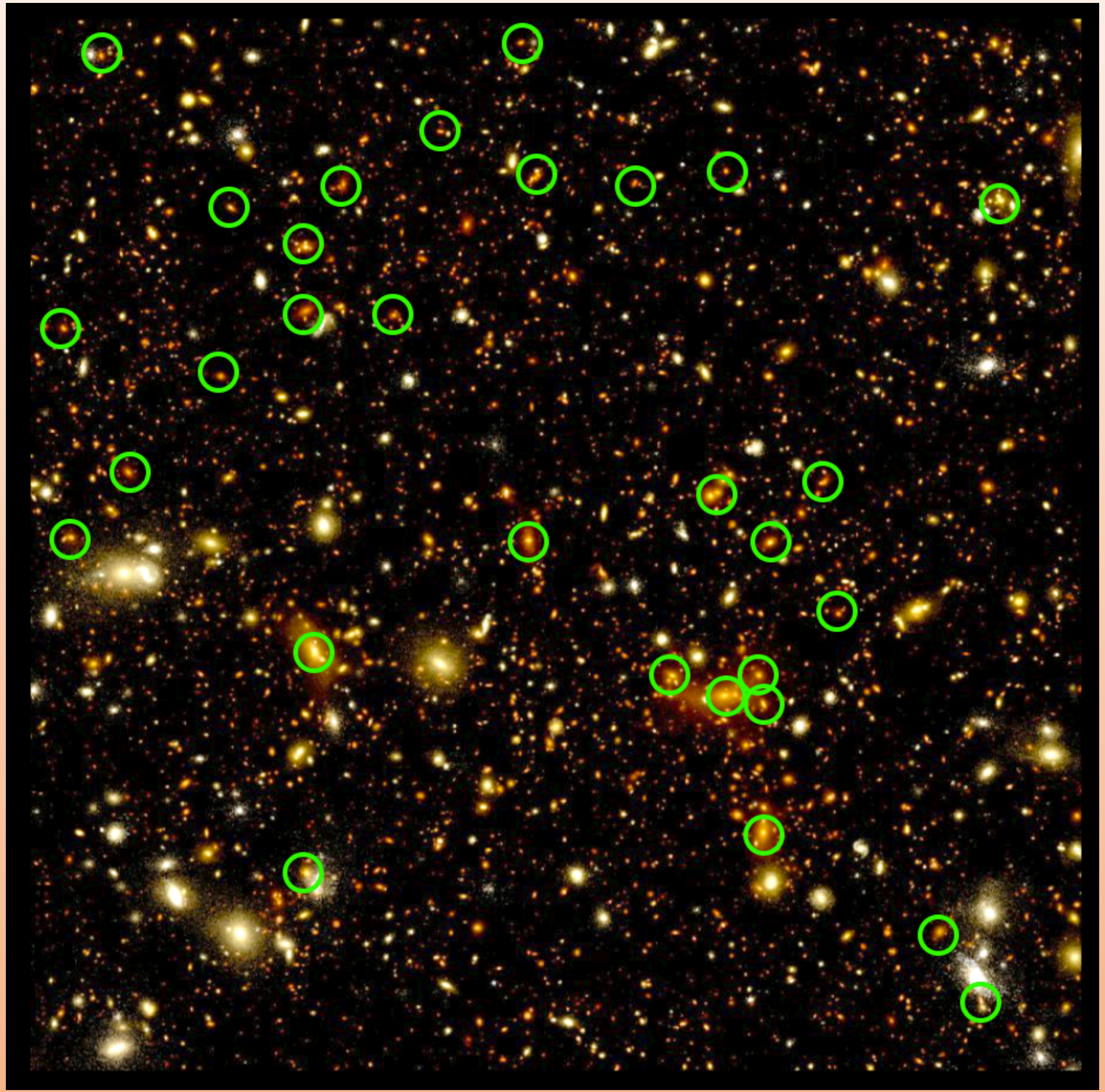
$Y \propto E_{gas,thermal}$

N	Type	z (mean)	Mass ($M_\odot$)	tSZ $Y (10^{-7}$ Mpc^2)
937	SPT+Planck	0.5 – 1.0 (0.72)	1.51×10^{11}	$2.2^{+0.9}_{-0.7}$
240	SPT+Planck	1.0 – 1.5 (1.17)	1.78×10^{11}	$1.7^{+2.2}_{-1.8}$
227	ACT+Planck	0.5 – 1.0 (0.83)	6.93×10^{11}	$1.5^{+1.6}_{-1.5}$
529	ACT+Planck	1.0 – 1.5 (1.21)	9.68×10^{11}	$1.9^{+1.3}_{-1.2}$

The Simulated Measurements: Horizon-AGN

- Horizon-AGN & Horizon-NoAGN
- Cosmological hydrodynamical simulation – RAMSES (100/*h* Mpc)
- AGN feedback:
  - High accretion:
    1.5% efficiency quasar-mode
  - Low accretion:
    10% efficiency radio-mode
- Params. chosen to match *z*=0 obs.

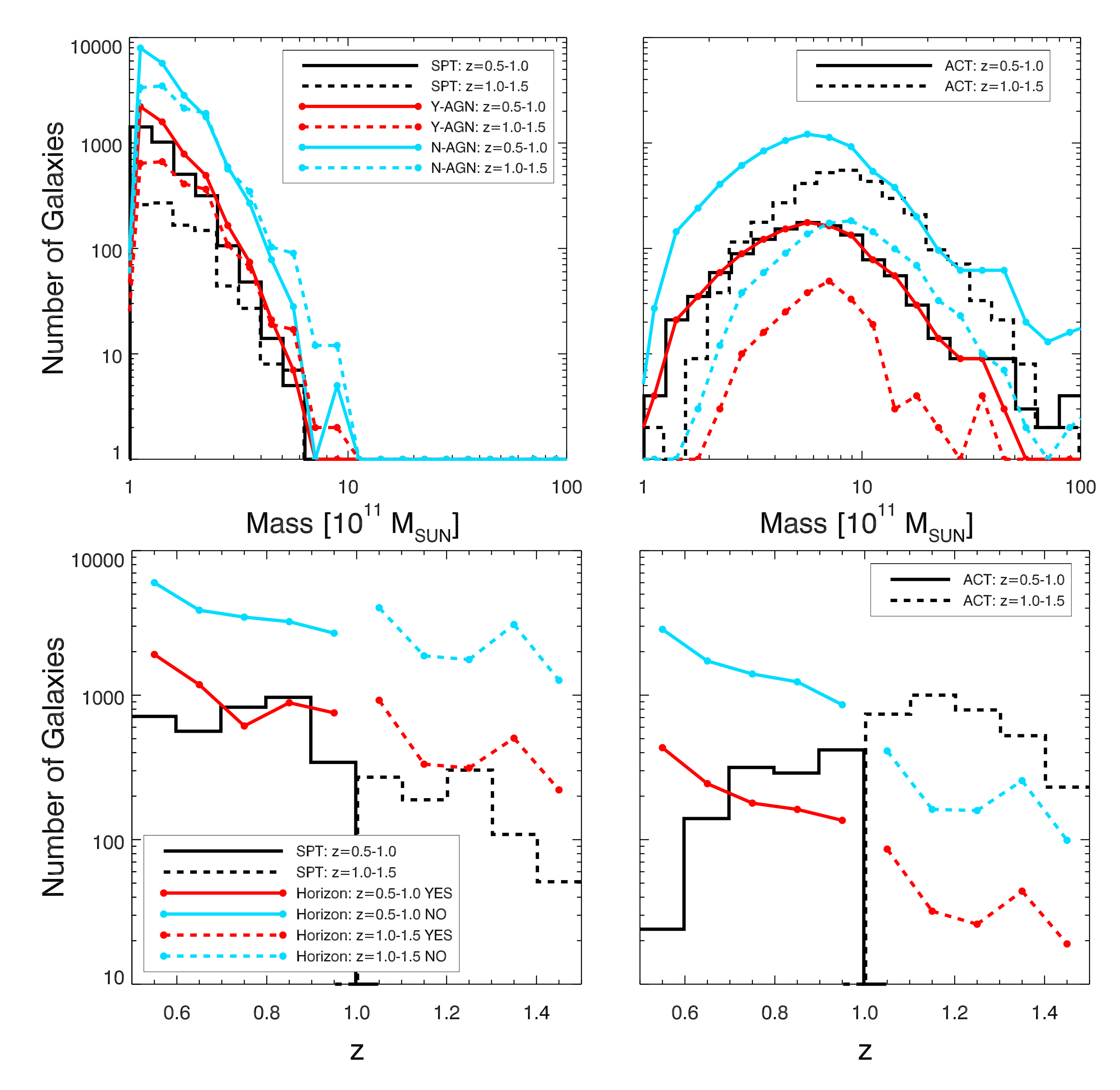
u, r, z mock image

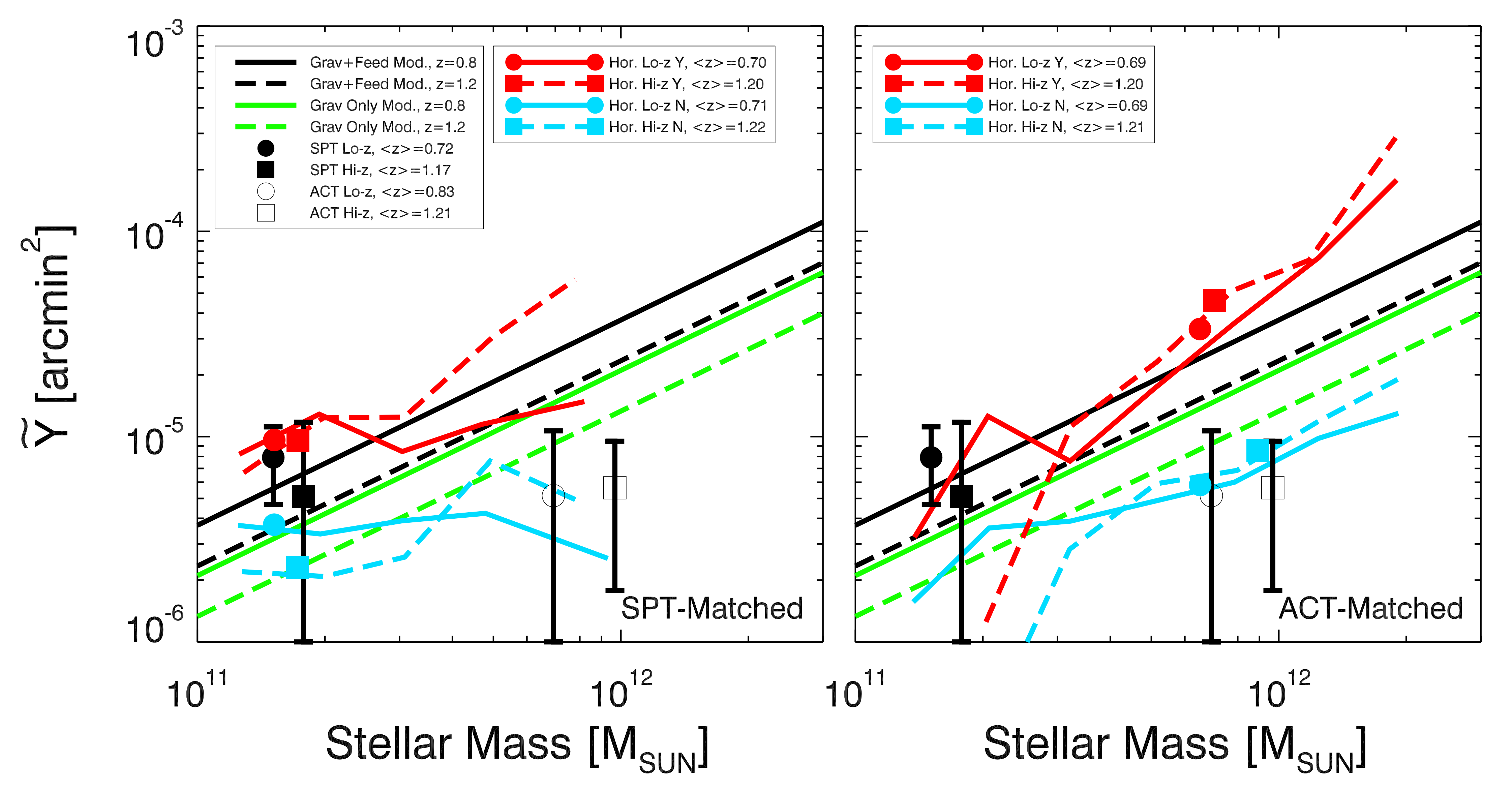


Spacek et al 2017 (in prep)

Mass

Redshift




Grav+Feed Mod., z=0.8
Grav+Feed Mod., z=1.2
Grav Only Mod., z=0.8
Grav Only Mod., z=1.2
SPT Lo-z, <z>=0.72
SPT Hi-z, <z>=1.17
ACT Lo-z, <z>=0.83
ACT Hi-z, <z>=1.21
Hor. Lo-z Y, <z>=0.70
Hor. Hi-z Y, <z>=1.20
Hor. Lo-z N, <z>=0.71
Hor. Hi-z N, <z>=1.22
Hor. Lo-z Y, <z>=0.69
Hor. Hi-z Y, <z>=1.20
Hor. Lo-z N, <z>=0.69
Hor. Hi-z N, <z>=1.21
$\tilde{Y}$ [arcmin^2]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{11}
10^{12}
SPT-Matched
ACT-Matched
Stellar Mass [M_{SUN}]

Further Work

- Look at simulations with different feedback prescriptions
  - New zoomed Horizon-AGN, ~20x resolution

- Much better observational data:
  - ACTPol, Advanced ACTPol
  - SPT-Pol, SPT-3G
  - LiteBIRD, TolTEC

Thank you!