Environment from Cross-Correlations: Linking Cause to Effect in Galaxy Quenching (arXiv:1907.06645)

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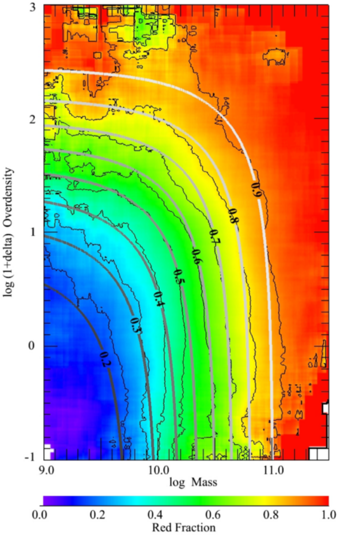
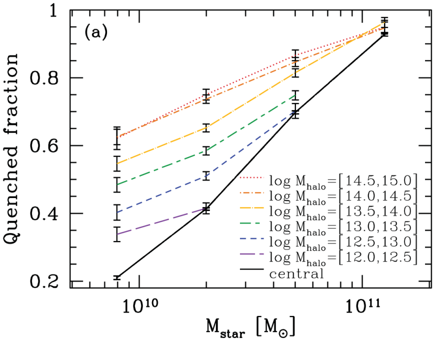
Satellites vs centrals

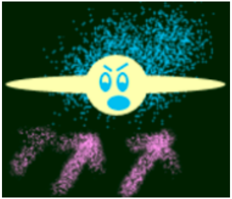
Peng et al. 2010

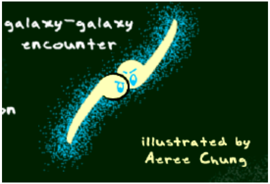




Wetzel et al. 2012

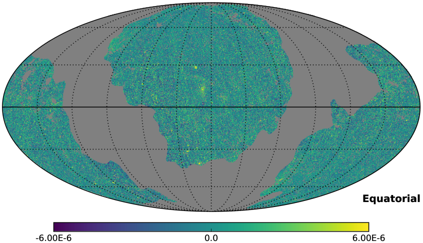
Quenching Processes





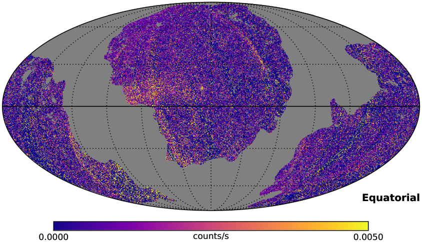
Hot gas	Gravity	Galaxies
Ram-pressure stripping	Tidal compression	Mergers
Turbulent viscous stripping	Harassment	Strangulation / Starvation

All sky surveys



Planck thermal Sunyaev-Zel'dovich effect.

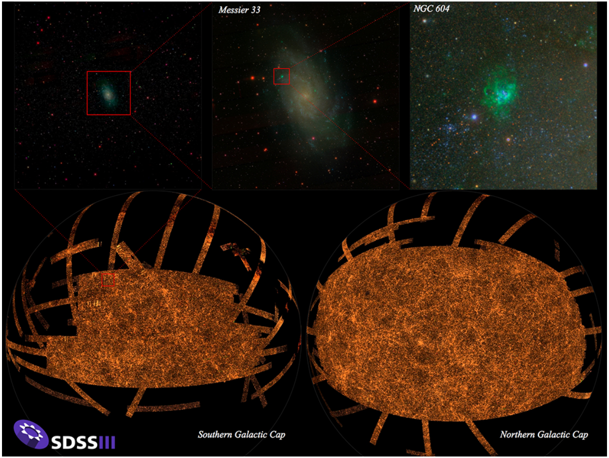
$$y_{tSZ} = \frac{\sigma_T}{m_e c^2} \int P_e dl$$



ROSAT All Sky Survey X-ray counts/s.

$$S_X = \frac{1}{4\pi(1+z)^4} \int n_e^2 \Lambda(T_e, Z) dl$$

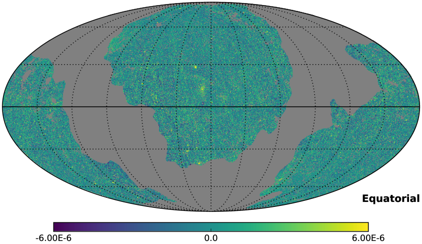
Galaxy survey: SDSS

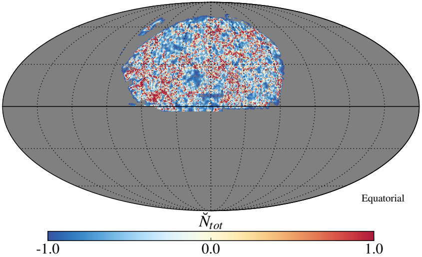


- Select a volume-limited sample
- $\log_{10}\mathrm{M}_* > 10$, $0.008 \leq \mathrm{z} \leq 0.15$

(Spatial) Cross-correlations

- Two-point statistic between two *different* maps
- *Direct* galaxy property – environment measure
- Uncorrelated features don't matter (noise)
- Do the same for hydro simulations:
  EAGLE
  (Schaye+ 2015, Crain+ 2015)
  BAHAMAS
  (McCarthy+ 2017)

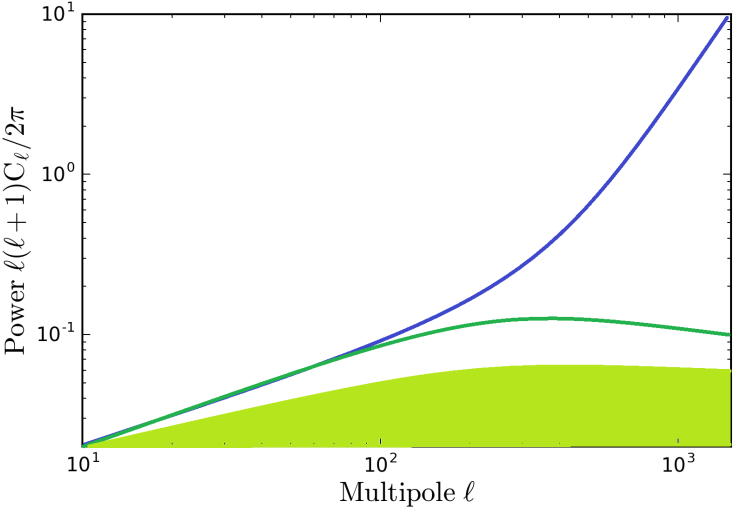




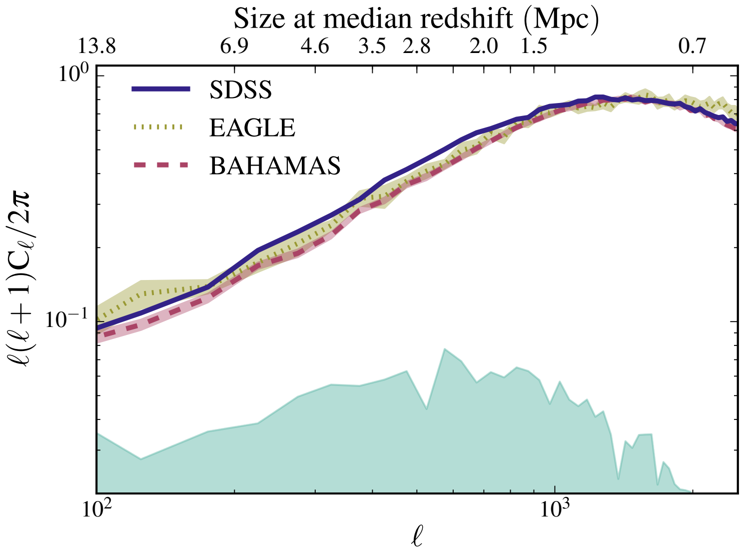
Pros / Cons of cross-correlation

- $+$ No need to find groups, assign galaxies - simple sample selection
- $+$ Extract z-dependent information from integrated quantities
- $+$ Overcome systematic effects of each survey
- $+$ Use a *direct* measure of environment, rather than a proxy
- $-$ Difficult to interpret
- $-$ Can be biased through beam / masking without knowing

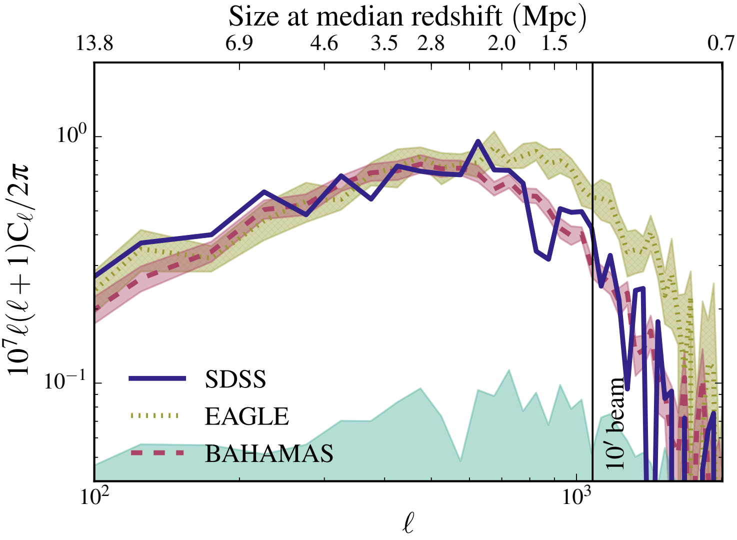
Results: expectations



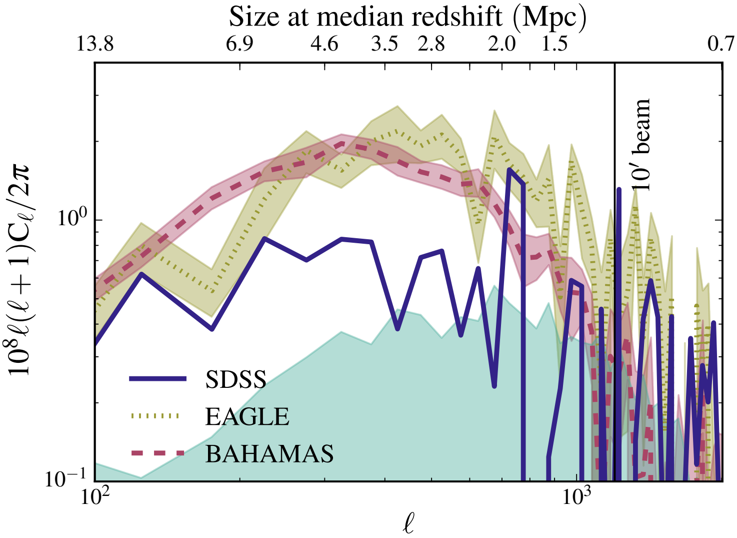
Results: $\mathrm{N_{tot} - N_{tot}}$



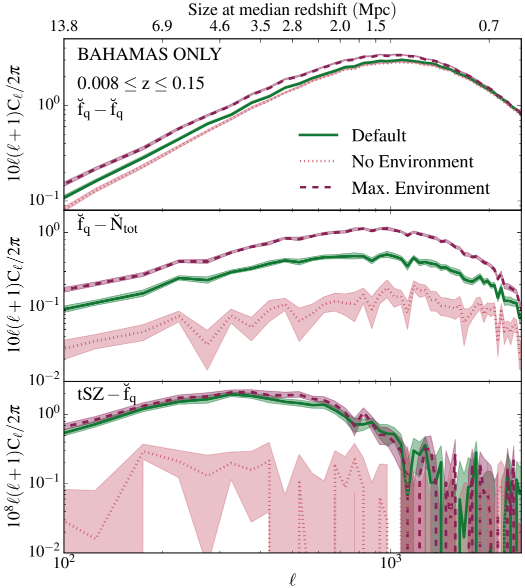
Results: tSZ − N



Results: $\mathrm{tSZ} - \mathrm{f_q}$



Isolate environment



In summary

- Large area surveys and spatial cross-correlations can be used to characterise environment
- Method very flexible: easily extended to other quantities
- Big improvements with next gen. instruments: CMB-S4, eROSITA, LSST, Simons Observatory, Euclid, DES, etc.