Angular power spectra of eROSITA mock cluster all-skymaps

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N-body simulations: why and how

Simulation	box	particles	m_p	ϵ	Ω_M	Ω_B	Ω_Λ	σ_8	n_s	H_0
BigMD27	2.5	3840^3	2.1×10^{10}	10.0	0.270	0.047	0.730	0.820	0.95	70.0
BigMD29	2.5	3840^3	2.2×10^{10}	10.0	0.289	0.047	0.711	0.820	0.95	70.0
BigMD31	2.5	3840^3	2.4×10^{10}	10.0	0.309	0.047	0.691	0.820	0.95	70.0
BigMDPL	2.5	3840^3	2.4×10^{10}	10.0	0.307	0.048	0.693	0.829	0.96	67.8
BigMDPLnw	2.5	3840^3	2.4×10^{10}	10.0	0.307	0.048	0.693	0.829	0.96	67.8
HMDPL	4.0	4096^3	7.9×10^{10}	25.0	0.307	0.048	0.693	0.829	0.96	67.8
HMDPLnw	4.0	4096^3	7.9×10^{10}	25.0	0.307	0.048	0.693	0.829	0.96	67.8

Klypin et al. (2016)

h^{-1} Gpc

Large volumes with different cosmological initial conditions

+

Phenomenological models for gas and temperature

=

Many mock cluster catalogues

Evolution of FZ, Pfrommer & Prada (2014)

Phenomenological model

Baseline model:

- Planck (2013 v) P(r) profiles + P_{500} scatter
- Hydrostatic bias: $M_{HE} = 0.8\ M_{sims(=true)}$
- $T - M_{500}$ and scatter (Mantz et al. 2010)
- Self-similar evolution
- Fixed metallicity = 0.3

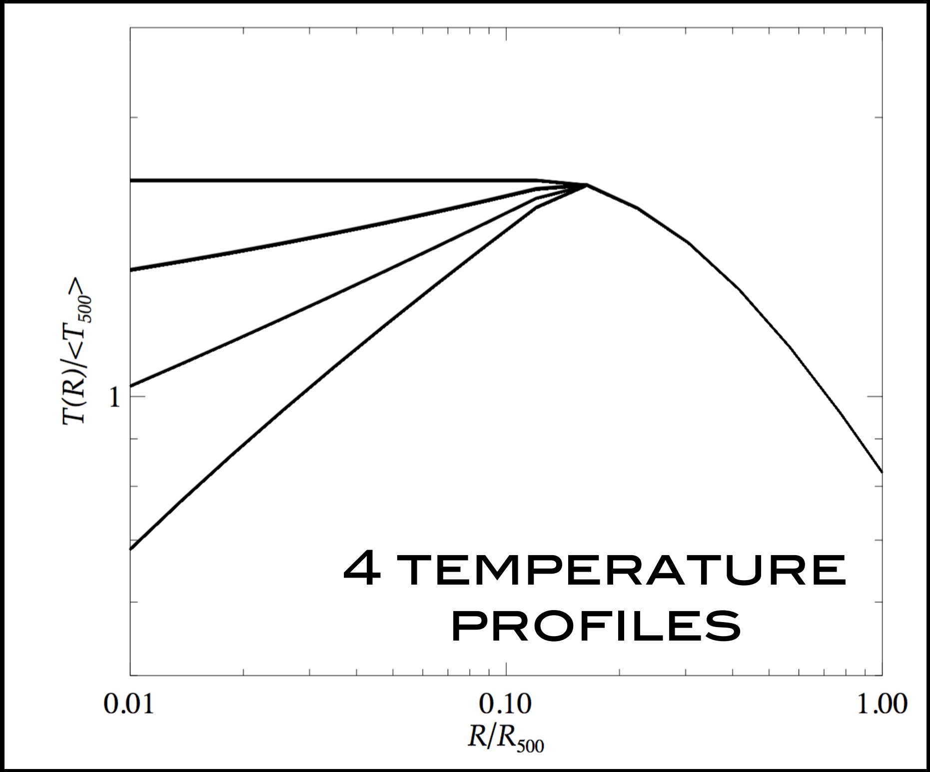
Cluster types (4 evolving populations):

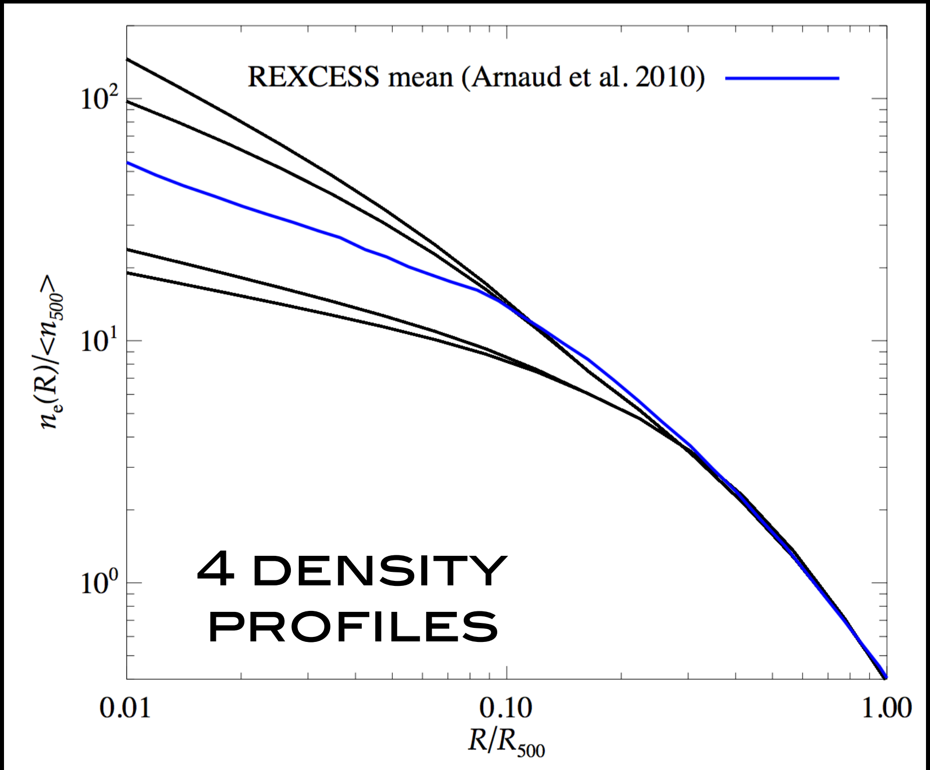
- Relaxed (=cool-cores) and merging
- Four inner ($\leq 0.15\ R_{500}$) temperature profiles (Hudson et al. 2010) + outer profile from hydro simulations (pfrommer et al. 2007)
- 25% fractions at $z = 0$ for $M_{500} \geq 5\times 10^{13}\ h_{70}^{-1}\ M_{\odot}$ using X_{off} parameter

Phenomenological model

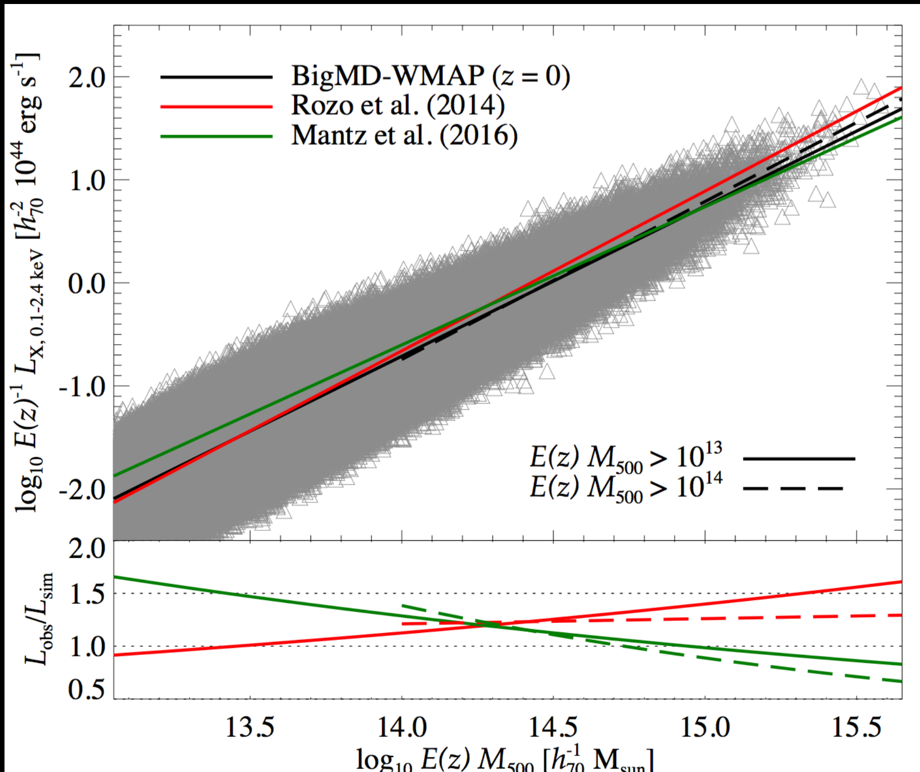
Relaxed → Cool-cores P(r) → $T_{DROP} = 0.4$ / $T_{DROP} = 0.6$

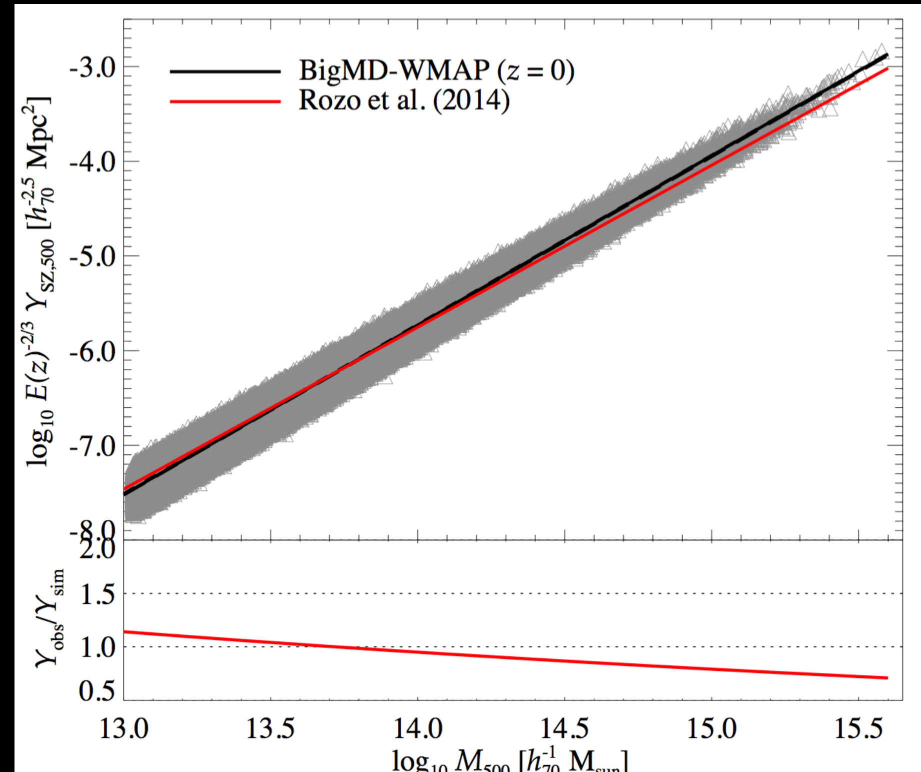
Merging → Non Cool-cores P(r) → $T_{DROP} = 0.8$ / $T_{DROP} = 1$





Baseline Scaling Relations





- Perfect match to Planck Y_{SZ} – M (Planck 2014 XX)
- Good match to Y_{SZ} – M of Rozo et al. (2014)
- Good match to L_X – M of both Rozo et al. (2014) and Mantz et al. (2016)
- Good match to Y_X (and fgas) – M of Vikhlinin et al. (2009)

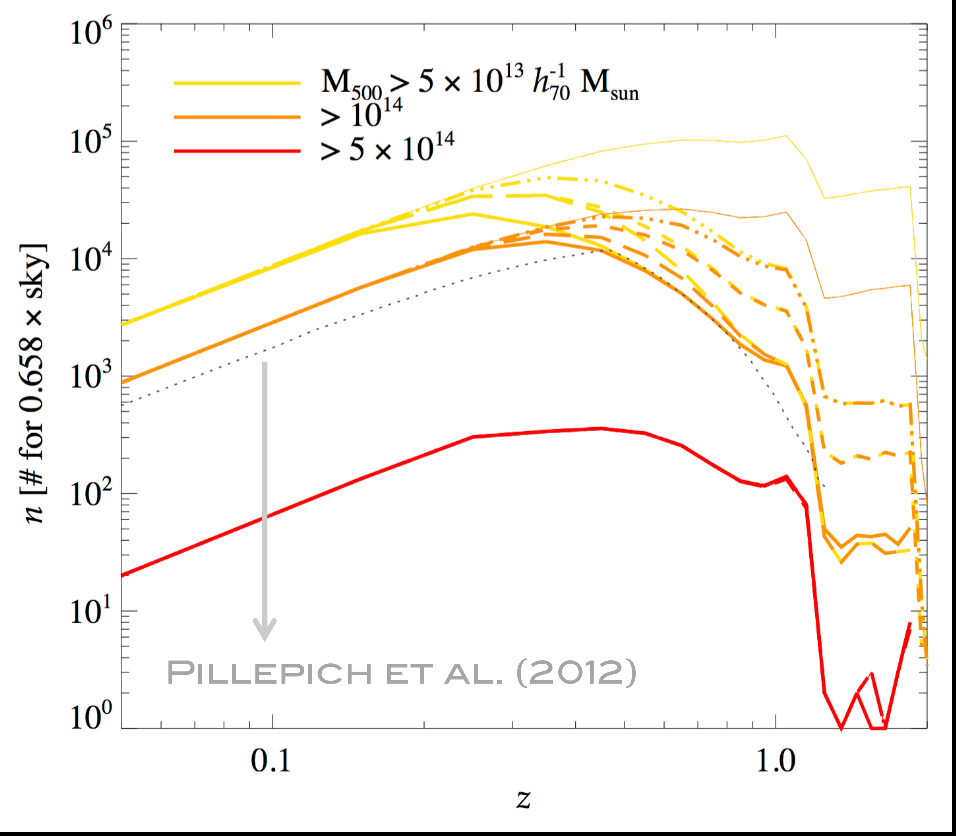
Baseline WMAP Light-cone

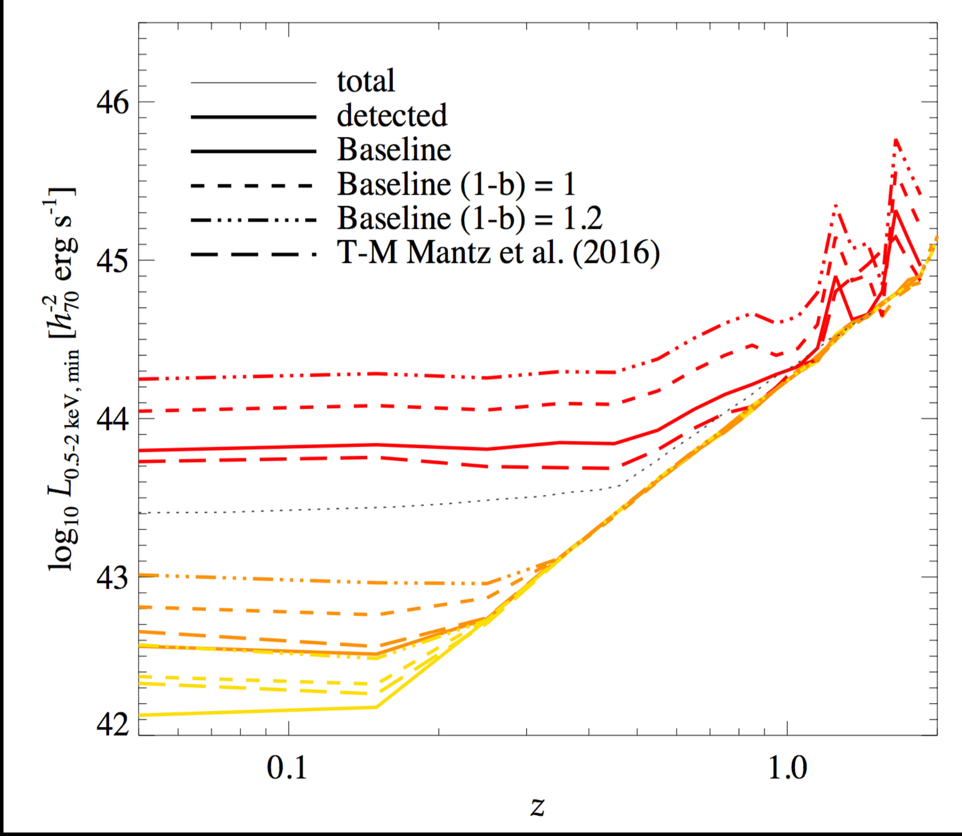
Projection as Fornasa et al. (2013) → random observers

eROSITA counts simulation as Pillepich et al. (2012)

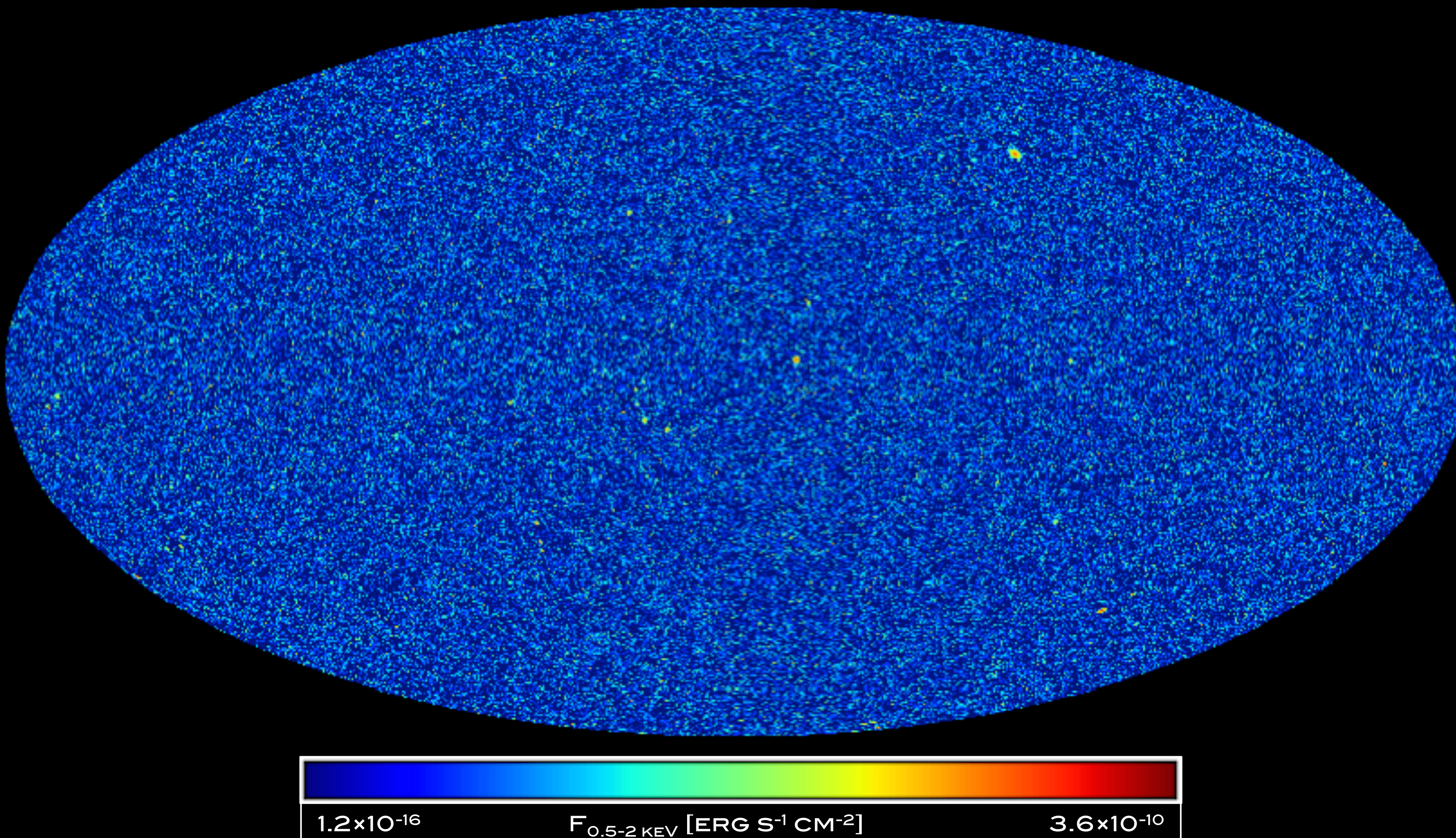
[0.658 of the sky for 1.6 ks and cut on counts ≥ 50]

with latest eROSITA response functions





Baseline Light-cone Skymap

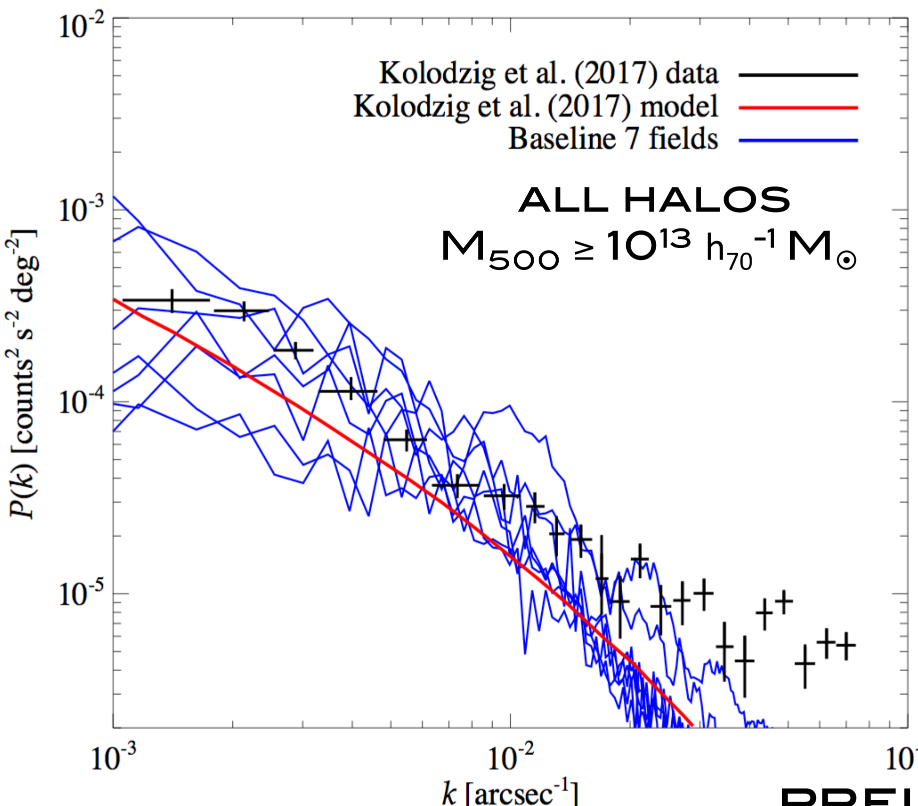


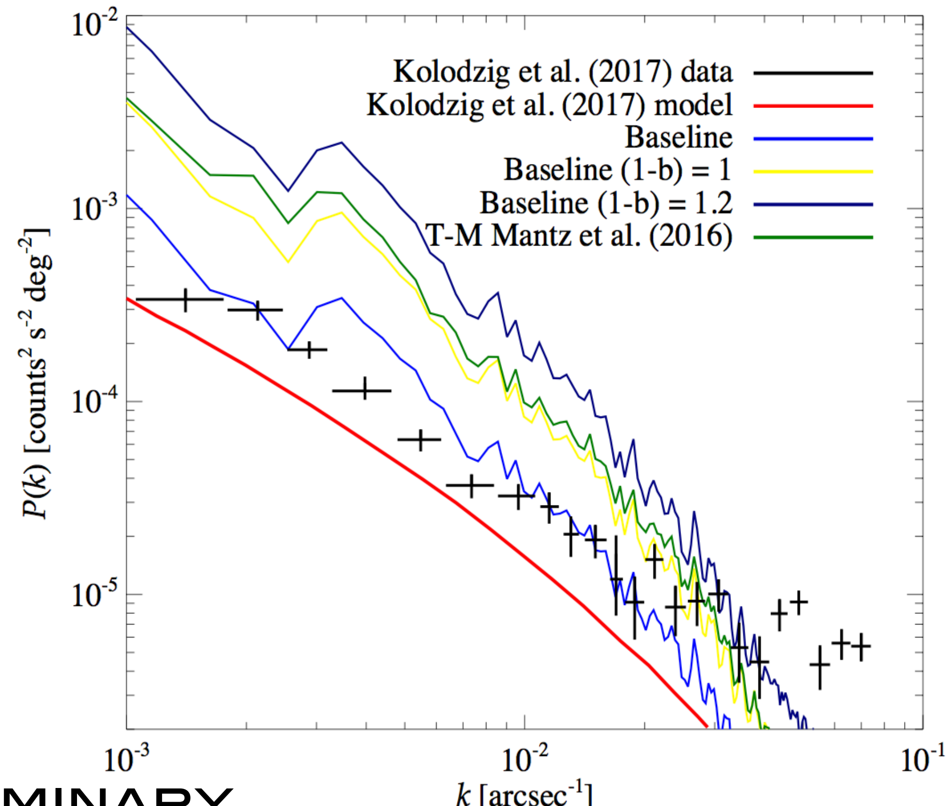
Power Spectra of Clusters

Comparing with XBOOTES analysis of the cosmic X-ray background by Kolodzig et al. (2017) [cluster model based on Cheng, Wu & Cooray 2004]

$$\langle|\widehat{\delta F}(k)|^2\rangle = \frac{2}{n(k)} \sum_{l}^{n(k)/2} |\widehat{\delta F}(\mathbf{k}_l)|^2$$

$$P(k) = \langle|\widehat{\delta F}(k)|^2\rangle - P_{\mathrm{Phot.SN}}$$



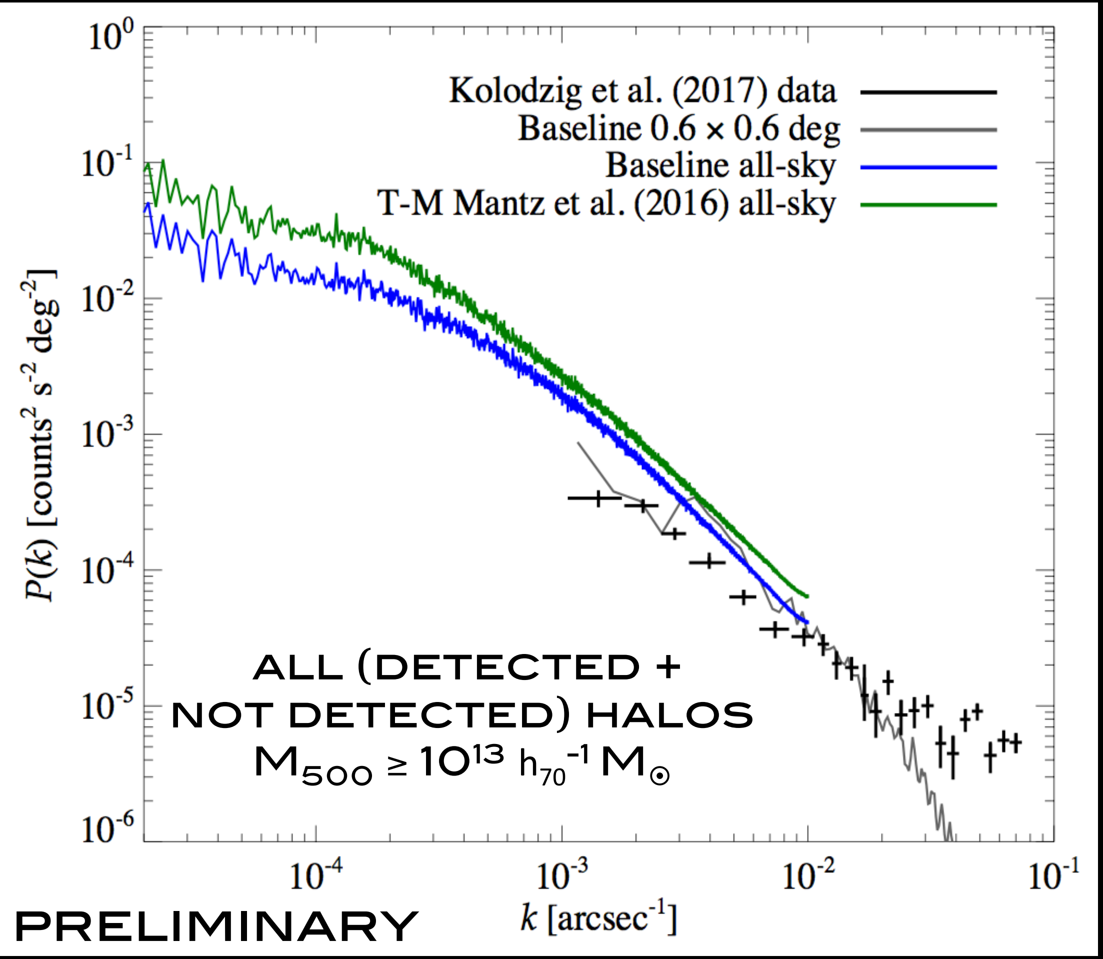


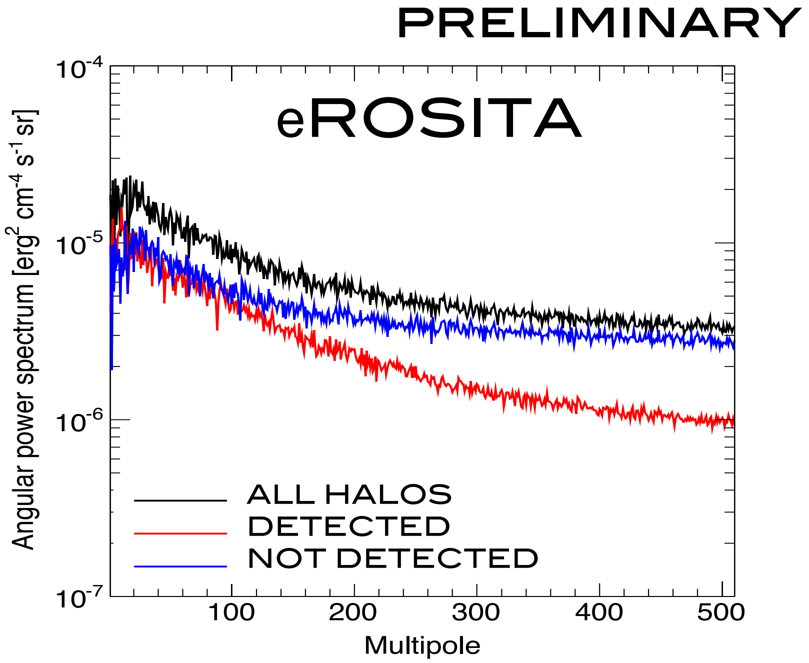
PRELIMINARY

All-sky Power Spectra

Overcome sample variance and unravel CXB

Great for studying cosmology and scaling relations of clusters (also with SZ signal)





$$C_\ell \equiv \langle |a_{\ell m}|^2 \rangle$$

$$a_{\ell m} = \int d\Omega_{\boldsymbol{n}}\, I(\boldsymbol{n})\, Y^*_{\ell m}(\boldsymbol{n})$$

Take-Home Messages

- Phenomenological model to assign gas and temperature to dark-matter-only halos
- Mocks with 4 evolving population of clusters of galaxies matching observations
- Light-cones for different observers with WMAP and Planck cosmology will be on-line
- Many applications are possible, we showed angular power spectrum:

  - Large variations on small (XBOOTES-like) sky patches → not good to draw general conclusions
  - Large variations among different models → very good for astrophysics & cosmology with clusters
  - All-sky eROSITA survey will change our understanding of the CXB and cluster scaling relations <u>with the CXB too</u>

Thanks!