Title: A multi-observation view of feedback: joint kinetic Sunyaev-Zeldovich, X-ray, and weak lensing measurements

Speakers: Jared Siegel

Collection/Series: Cosmic Ecosystems

Subject: Cosmology

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Abstract:

There is no consensus on how baryonic feedback shapes the underlying matter distribution. This uncertainty is a limiting systematic for cosmic shear inference, particularly in the era of LSST, and a fundamental question in the study of galaxy evolution. Modern simulations are tuned to reproduce a variety of galaxy observations, however, previous studies demonstrated that the implied amplitude of baryon feedback is dependent on the chosen observable: e.g., X-ray gas fractions, which are sensitive to material within the virial radius of massive clusters, or kinematic Sunyaev Zeldovich (kSZ) profiles, which extend to a few virial radii [Bigwood+2024, McCarthy+2024]. In this talk, we address the uncertain observational landscape, by adopting a multi-observation view of feedback. We will present measurements for the gas and mass distribution as seen by eROSITA X-rays, DESI+ACT kSZ, and galaxy-galaxy lensing across a wide range of redshifts ($0<z<0.8$) and halo masses (13-15). Informed by the galaxy-galaxy lensing profiles, we perform a like-with-like comparison between the observations and the FLAMINGO simulations. By constraining the gas distribution across a range of scales (i.e., kSZ versus X-ray gas fractions), redshifts, and halo masses, we are working towards a complete picture of baryon feedback.

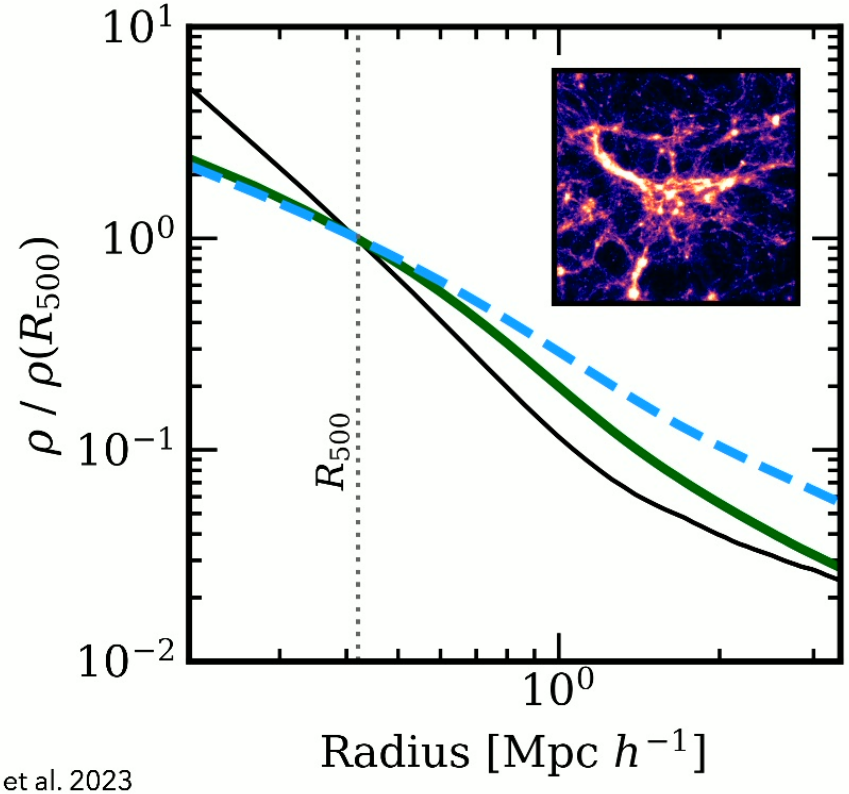
Building a Complete Picture of Baryon Feedback

Jared Siegel, Princeton University

Alex Amon, Leah Bigwood,

Masaya Yamamoto & Ian McCarthy

How do we observe feedback?



Schaye et al. 2023

Total matter

Hot Gas | FLAMINGO

Hot Gas | Strong AGN

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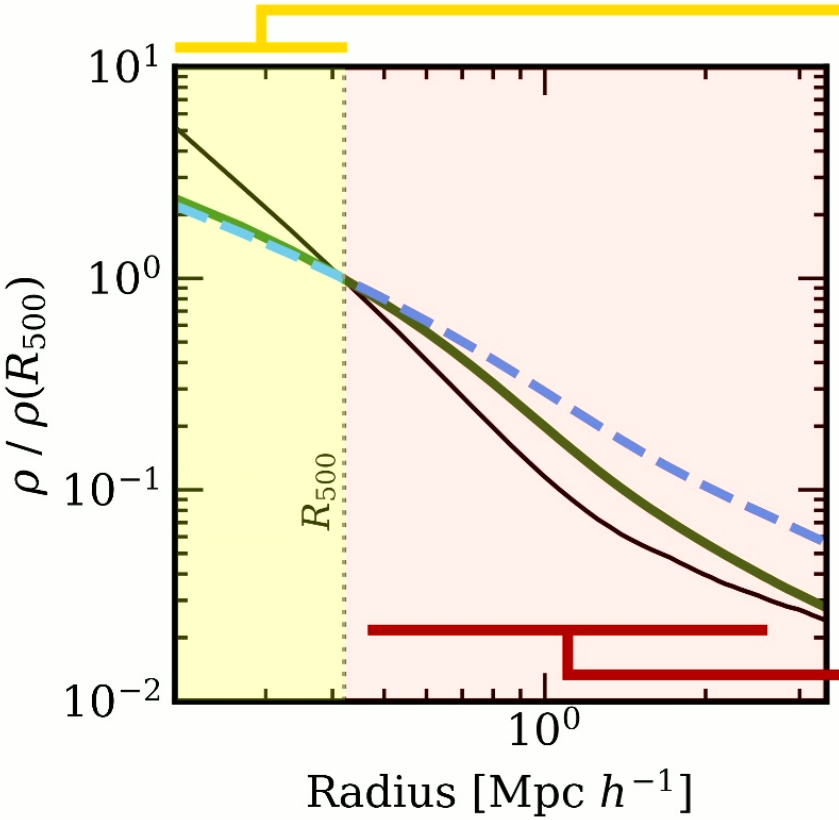
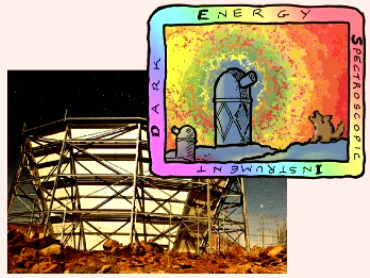


X-ray Hot Gas Fractions

eROSITA

kSZ Effect



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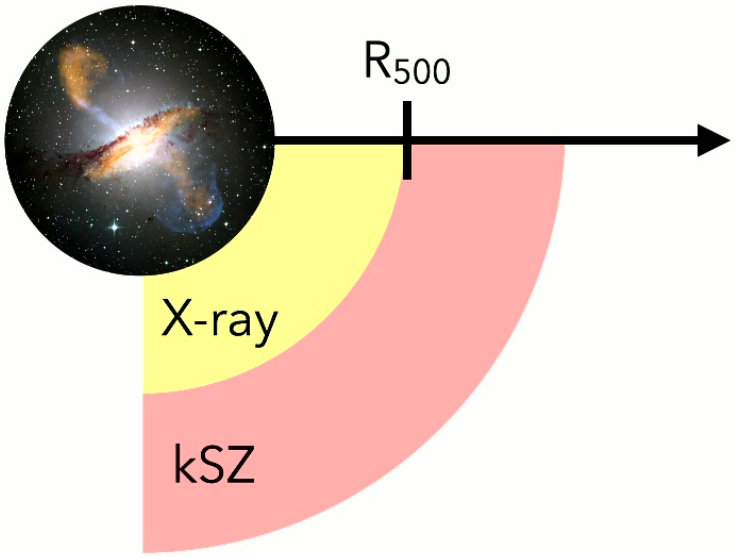
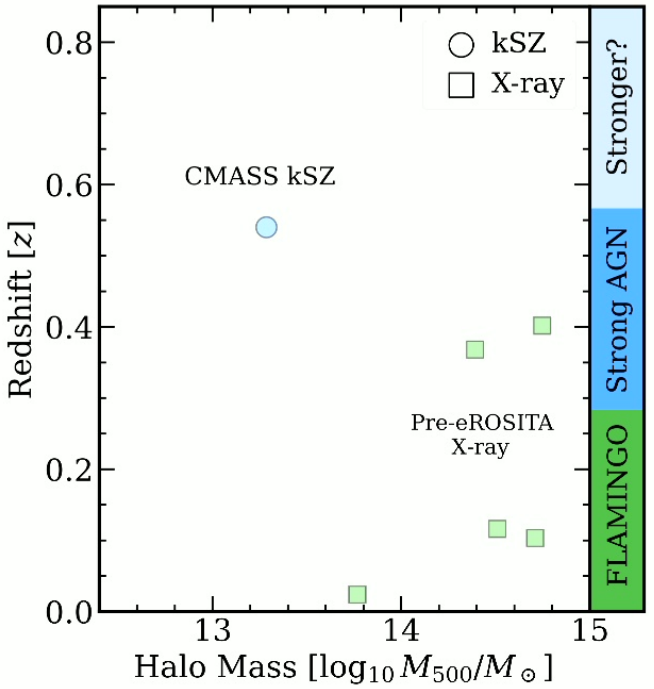
Building a Complete Picture

Are we explaining all scales? all masses? all redshifts?





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Building a Complete Picture

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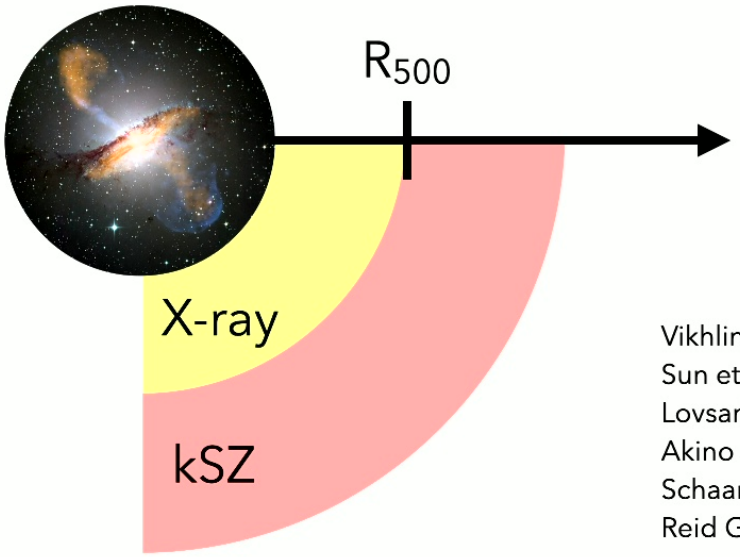
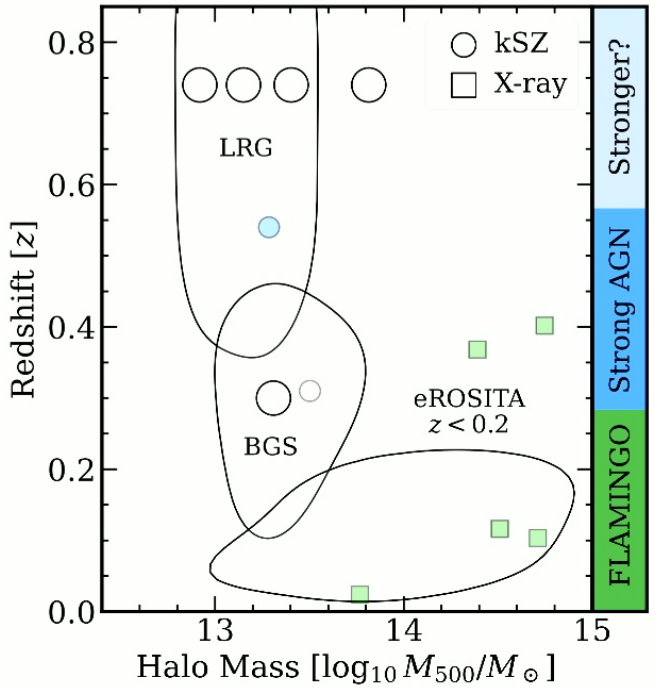


Vikhlinin et al. 2006
Sun et al. 2009
Lovsari et al. 2015
Akino et al. 2022
Schaan et al. 2021
Reid Guachalla et al. 2025



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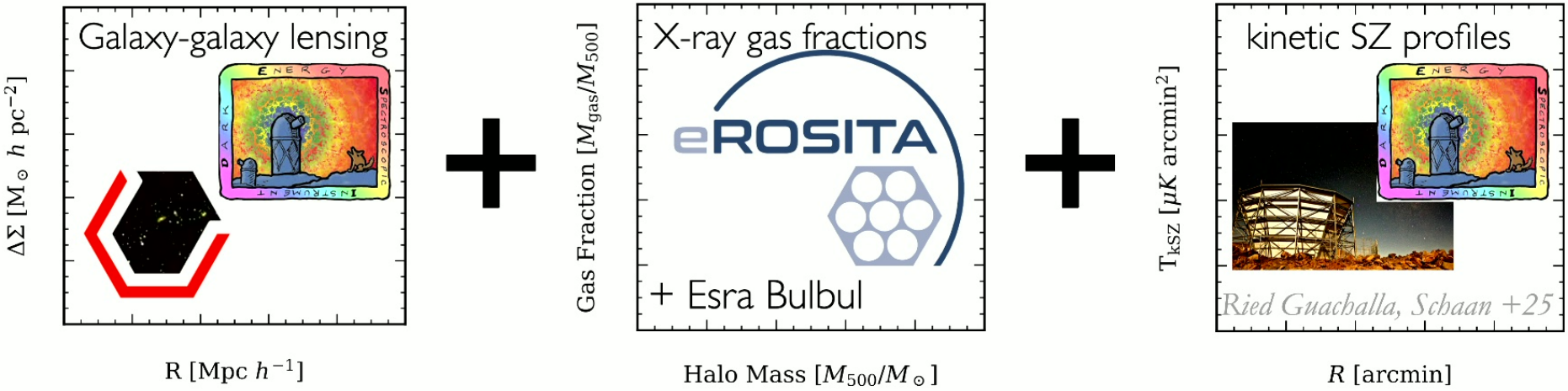

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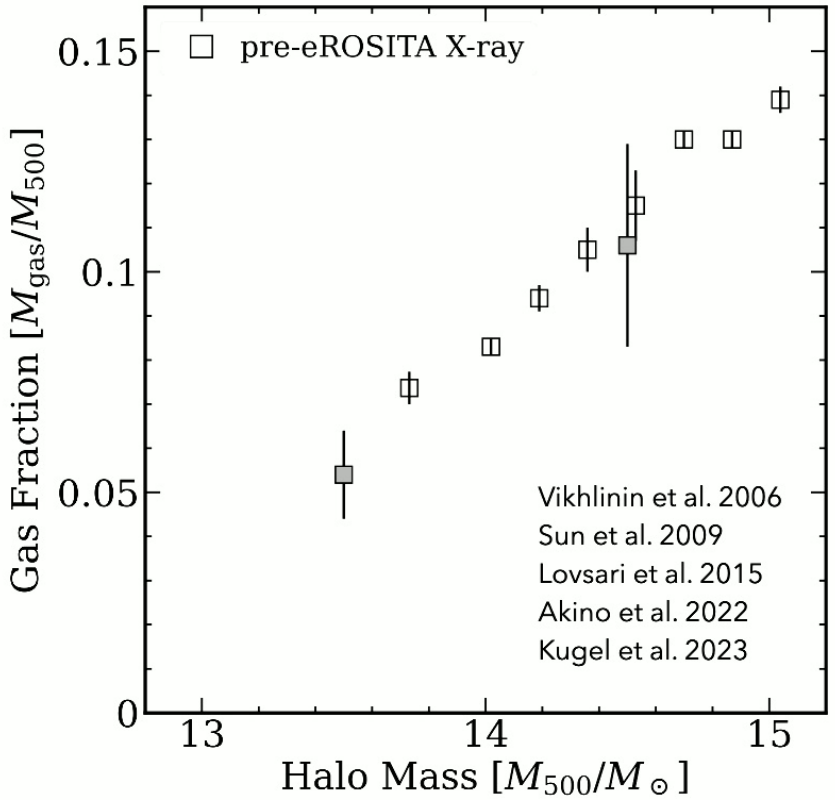
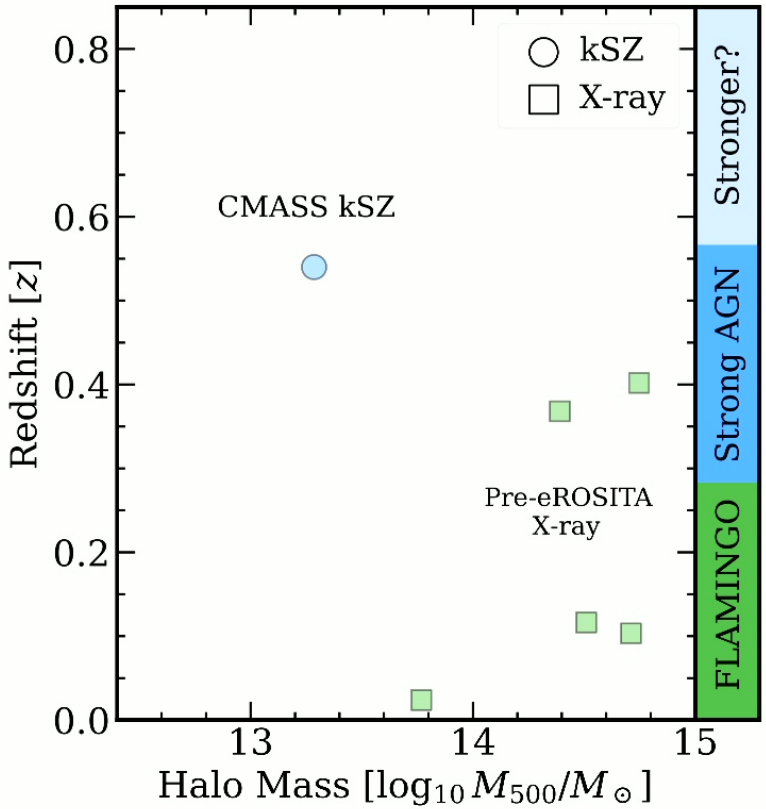
eROSITA+WL Gas Fractions





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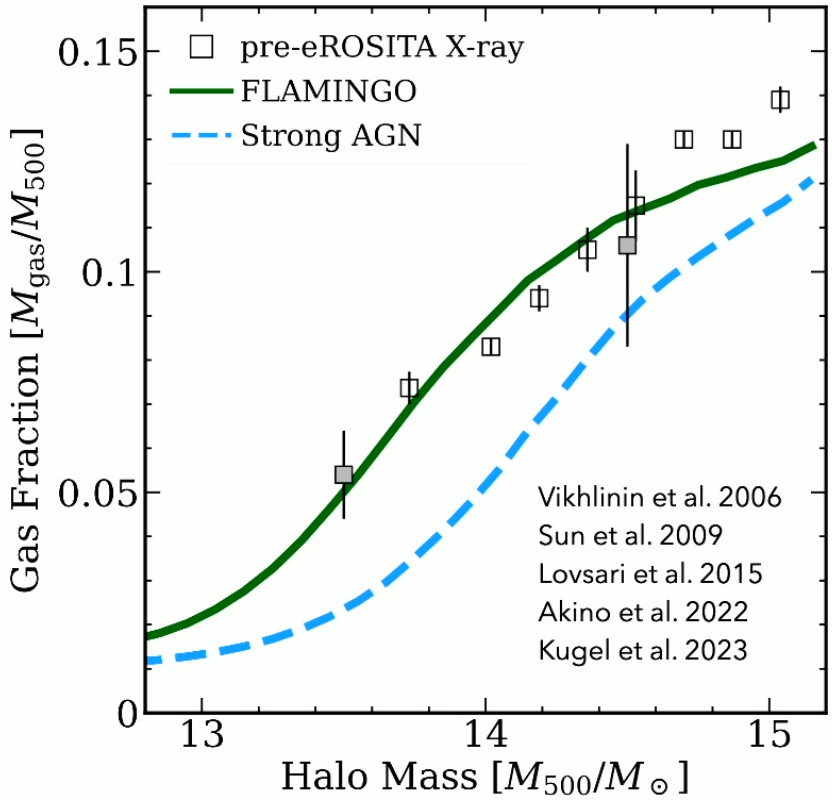

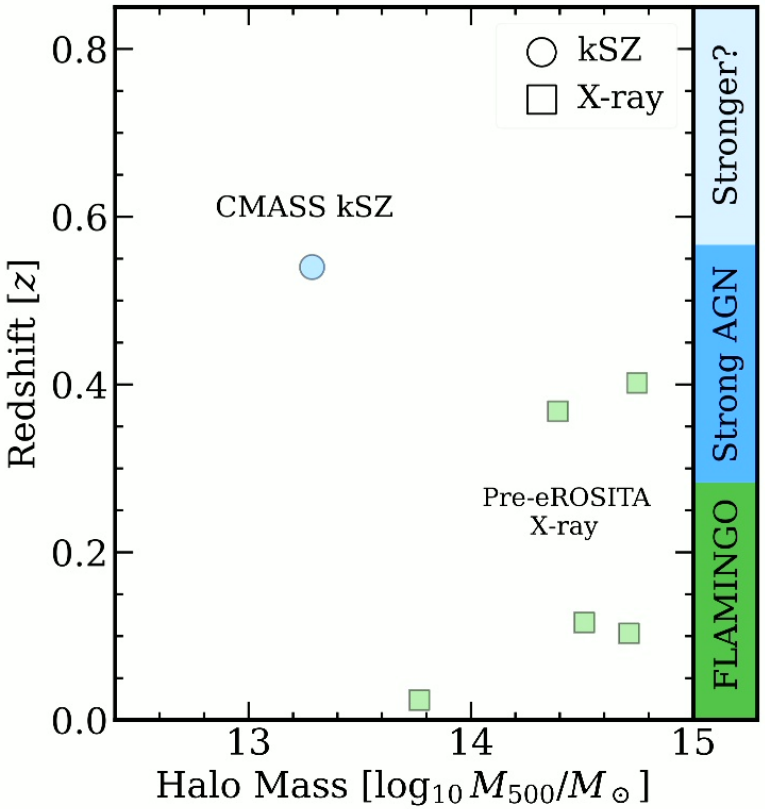

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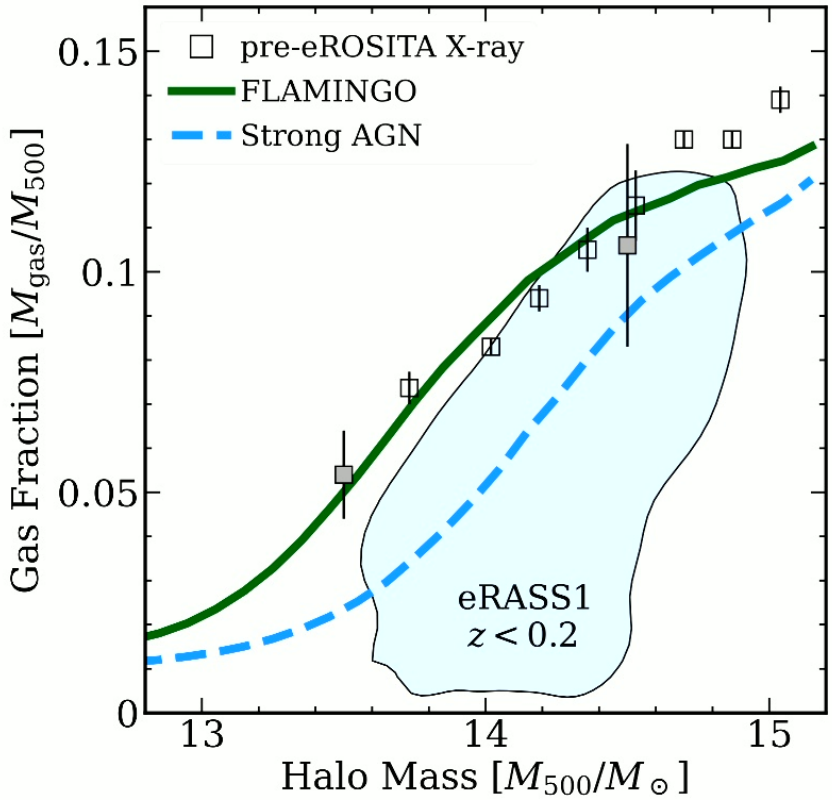
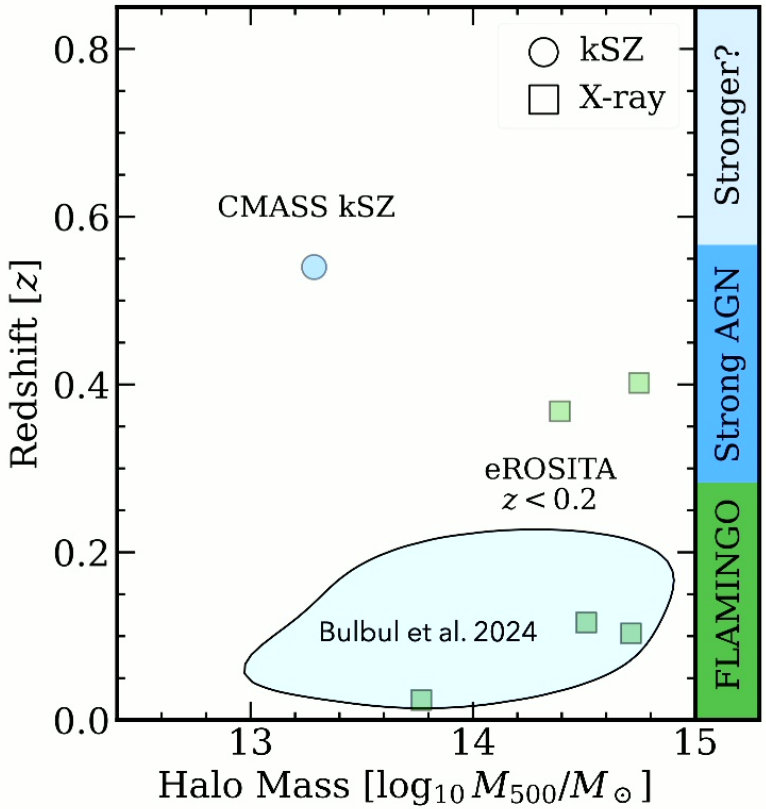
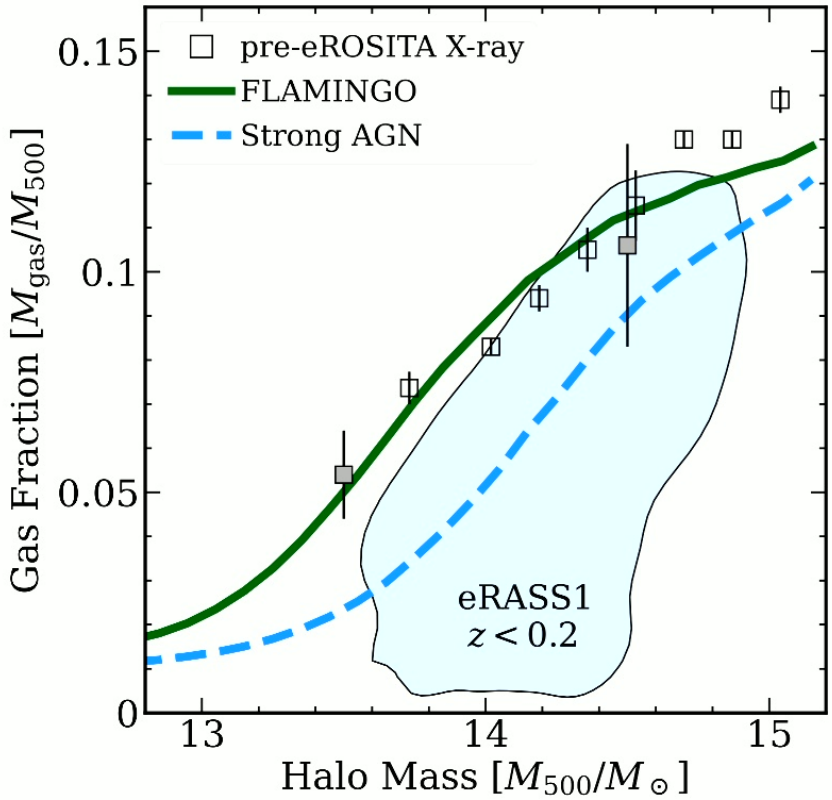
eROSITA+WL Gas Fractions





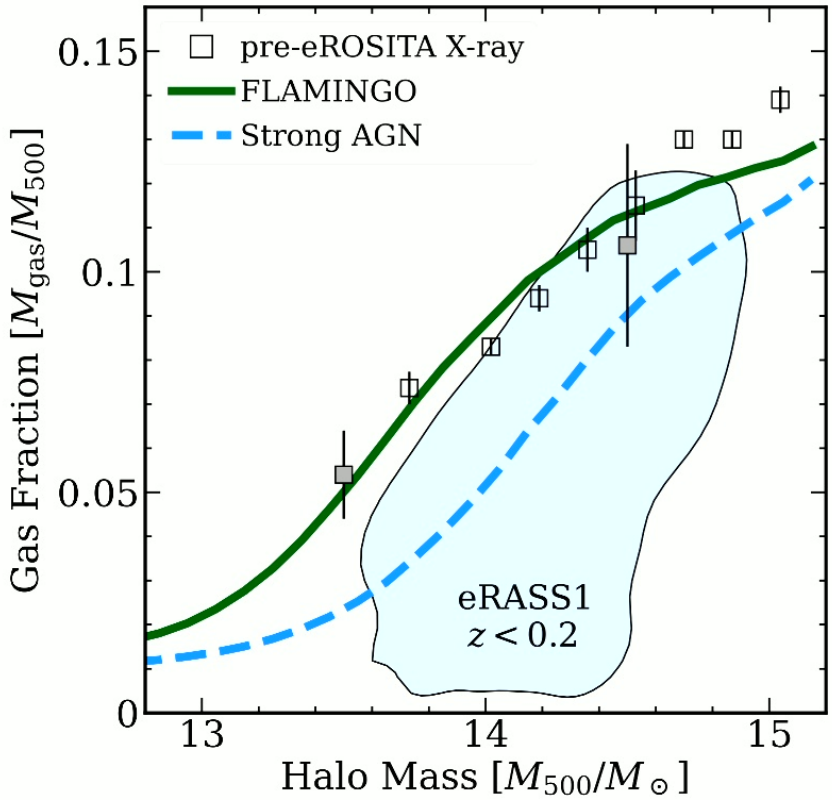
eROSITA+WL Gas Fractions



Selection effects?

Halo mass estimates?

eROSITA+WL Gas Fractions



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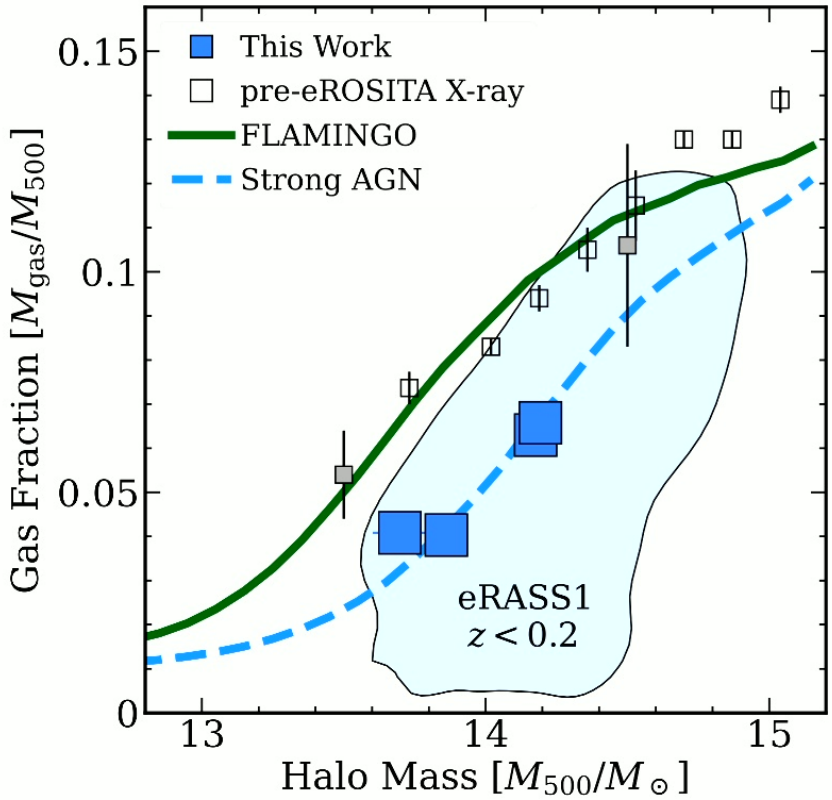

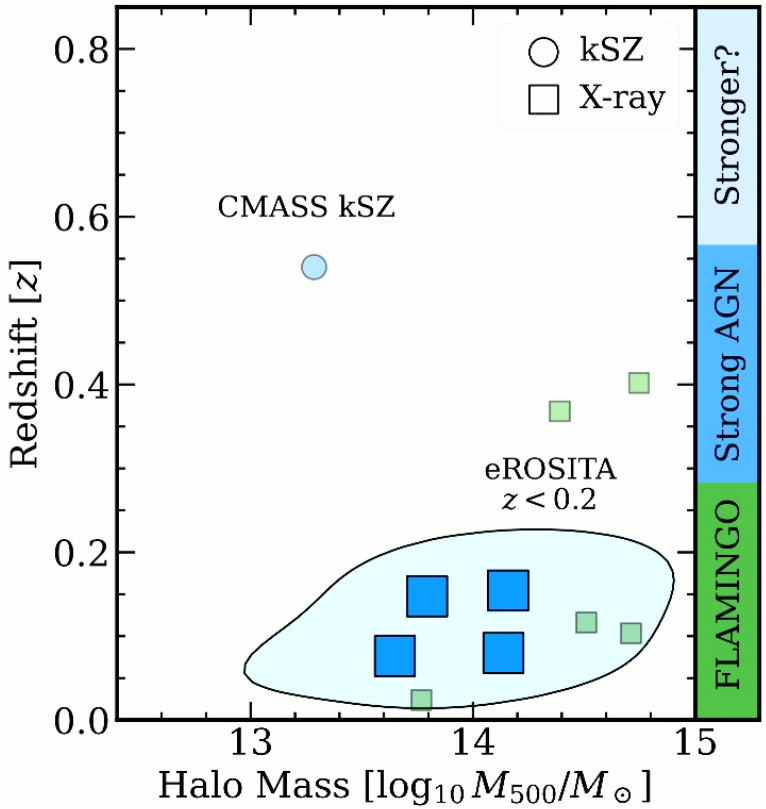

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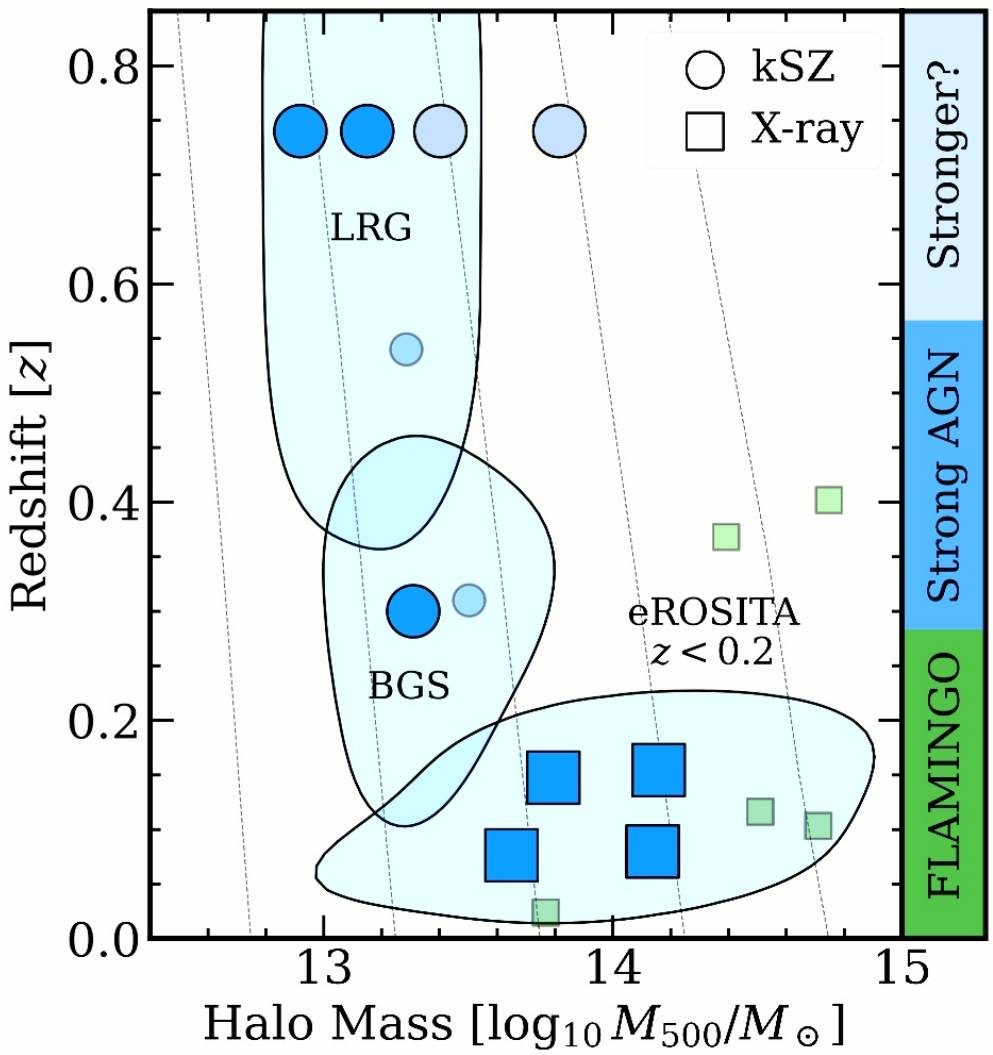
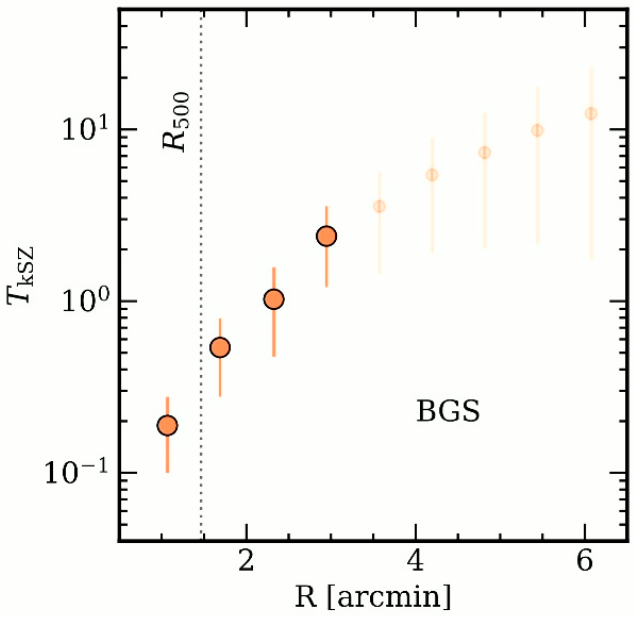
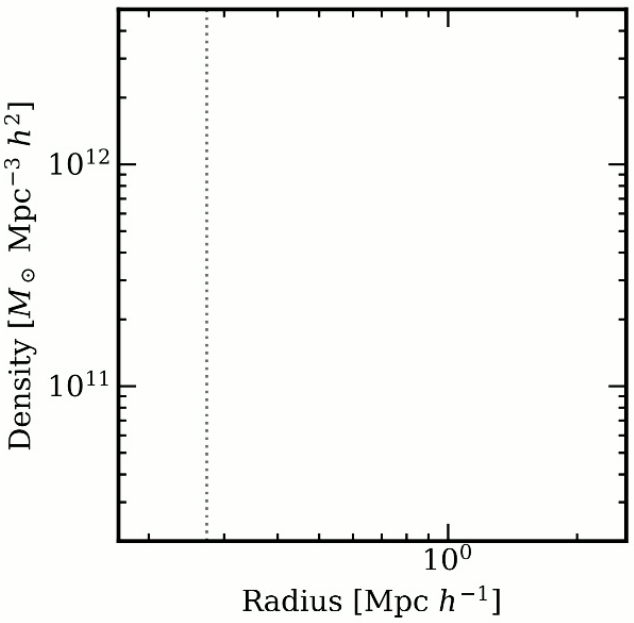
Landscape of Feedback



Building a Complete Picture

Analytic Modeling



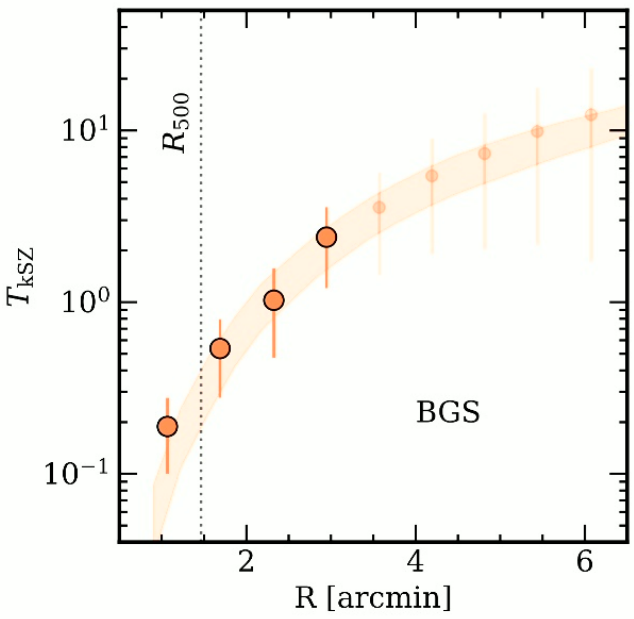


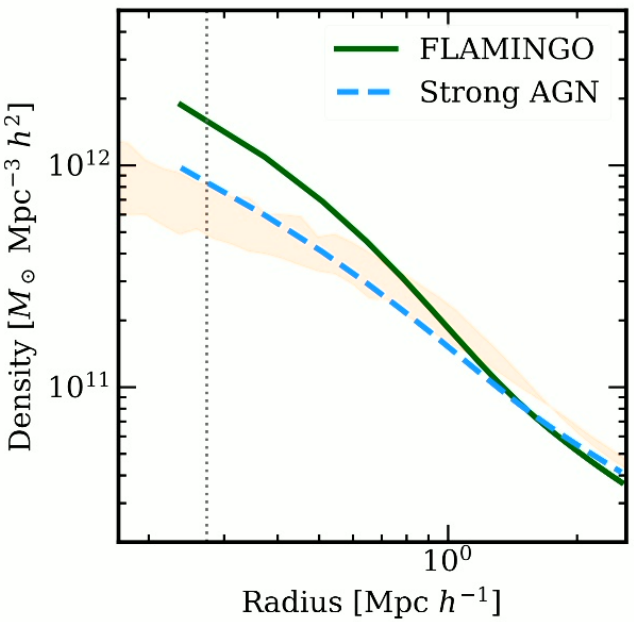
$$\rho(r \mid \theta, M_{500}, z)$$

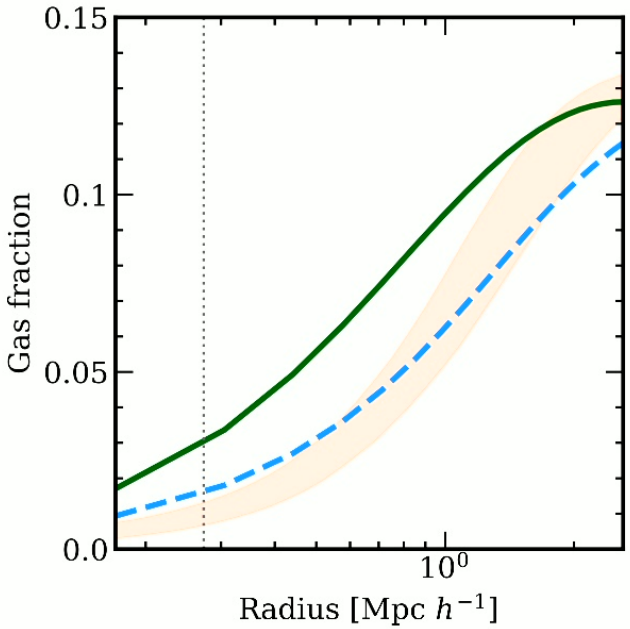
Schneider & Teyssier (2015)
Giri & Schneider (2021)
Oppenheimer et al. (2025)
Kovac et al. (2025)

Building a Complete Picture

Analytic Modeling







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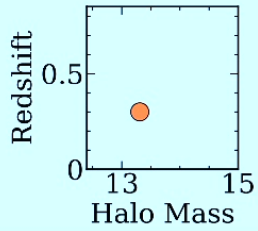

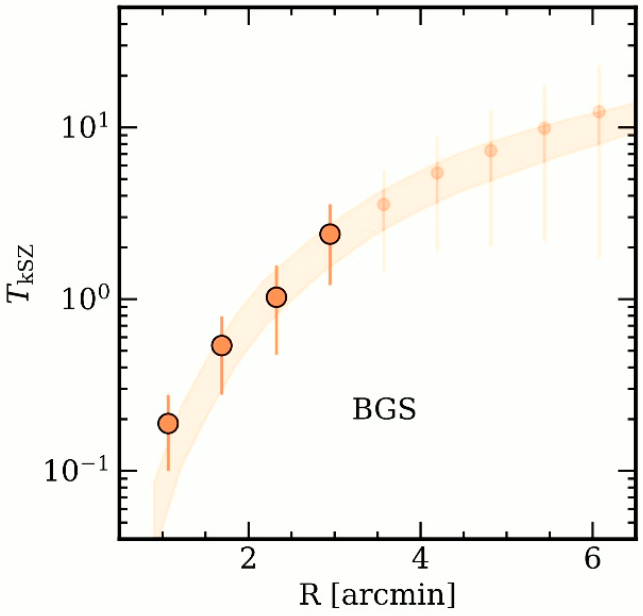

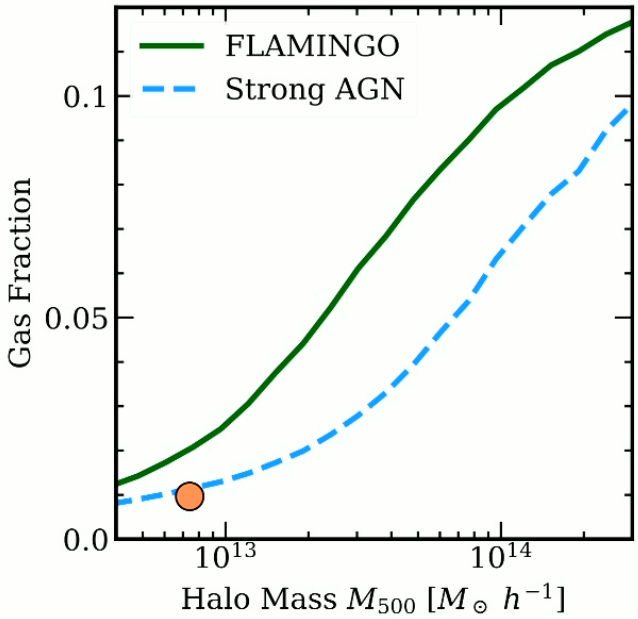

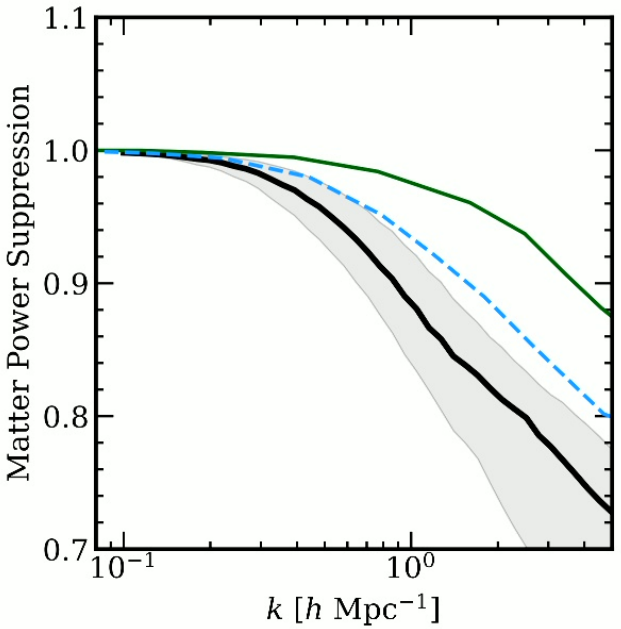

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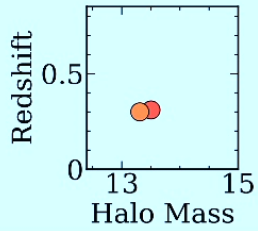

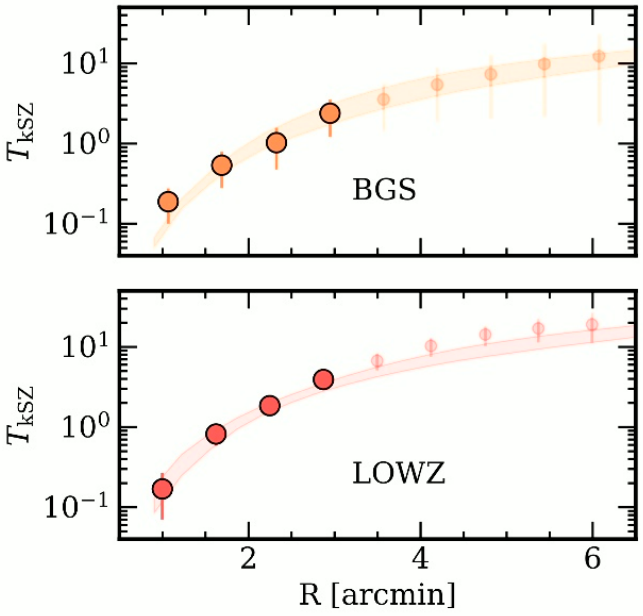

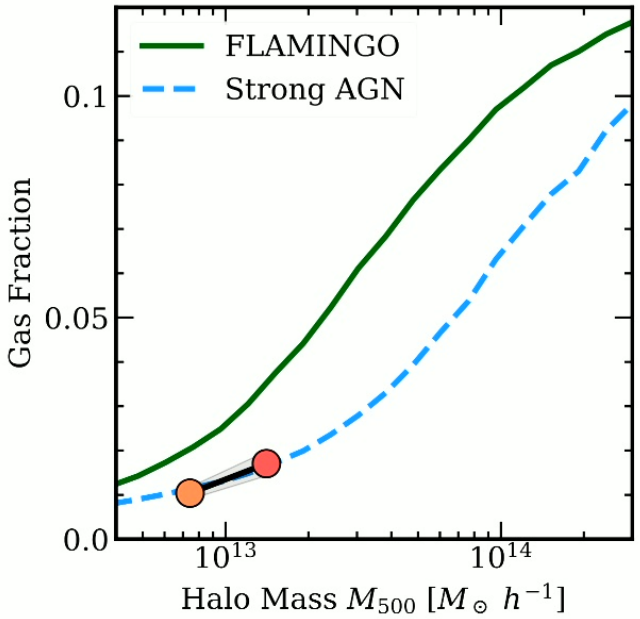

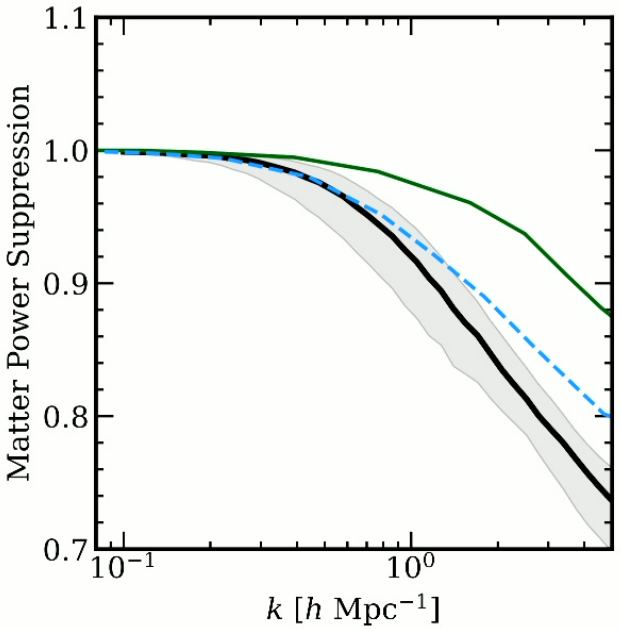

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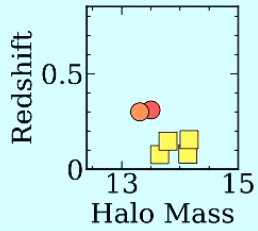

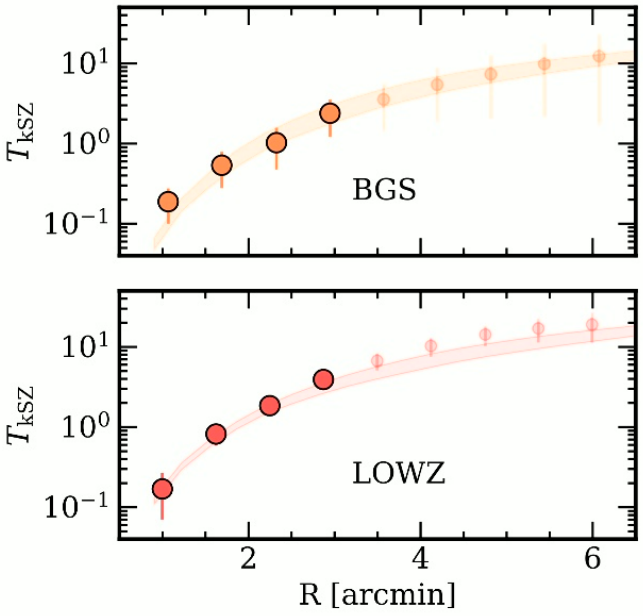

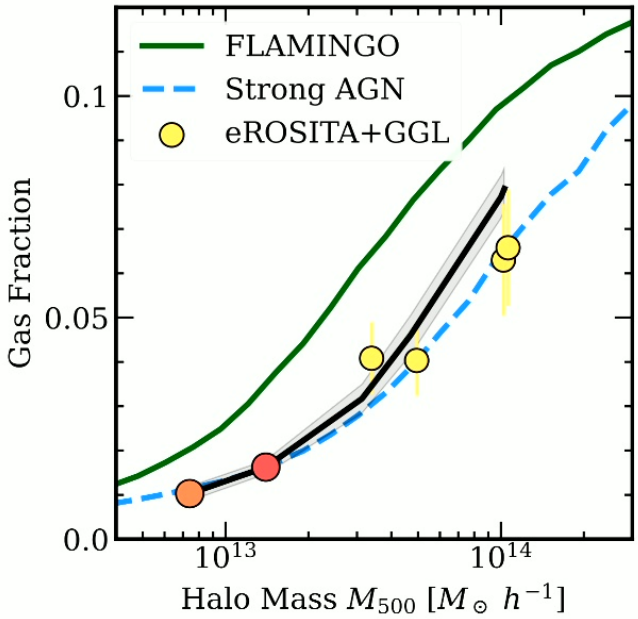

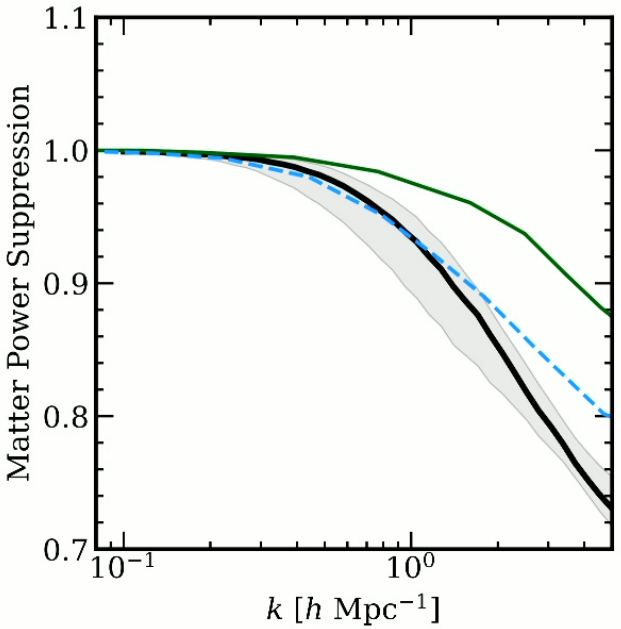

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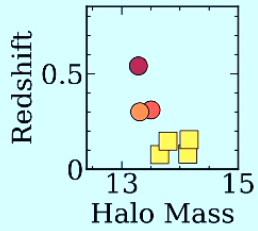

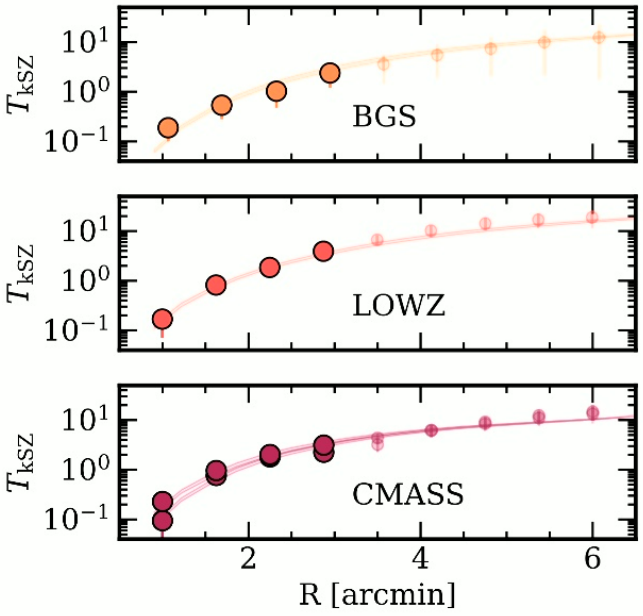

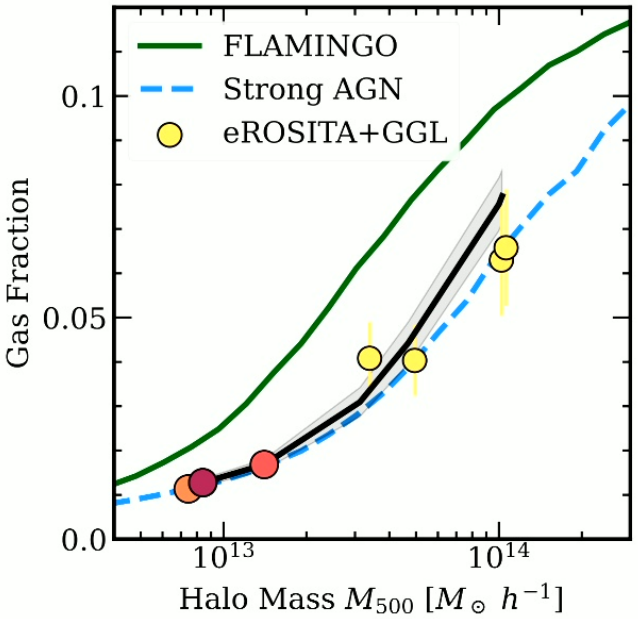

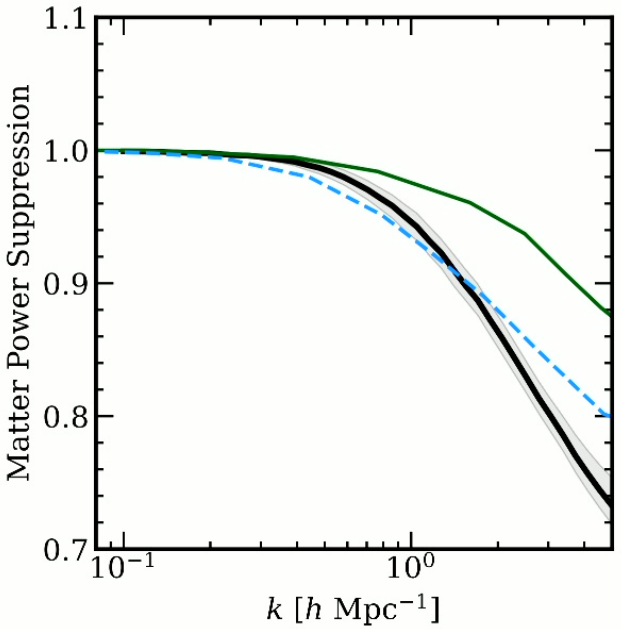

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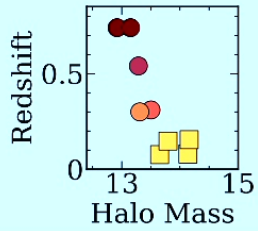

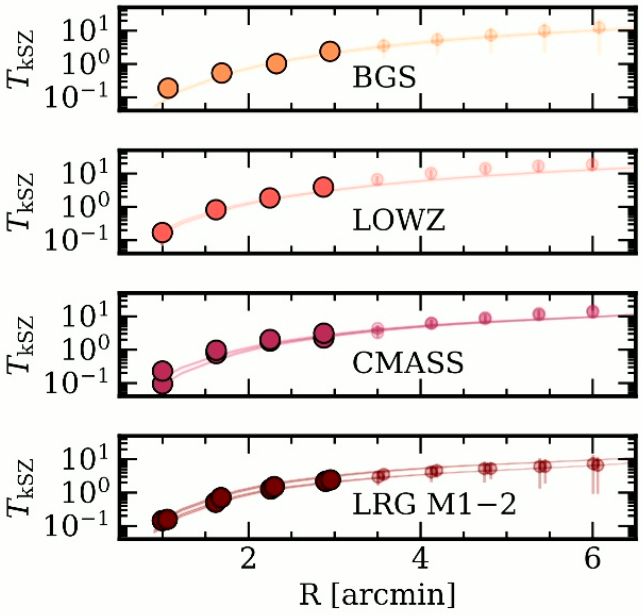

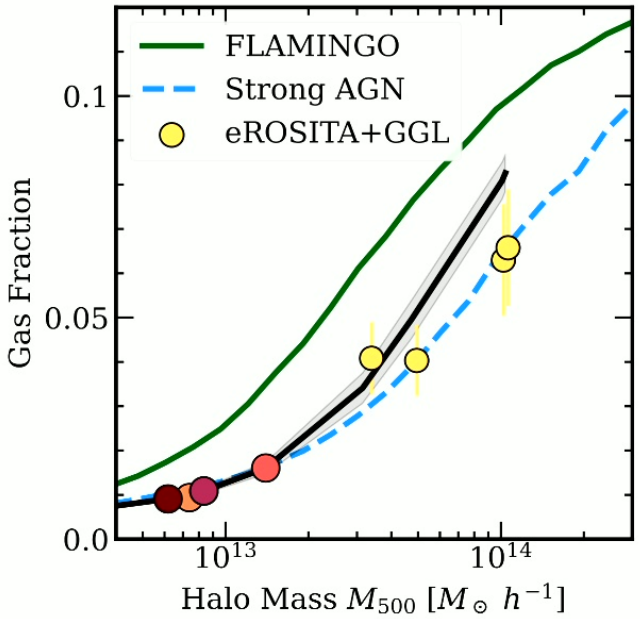

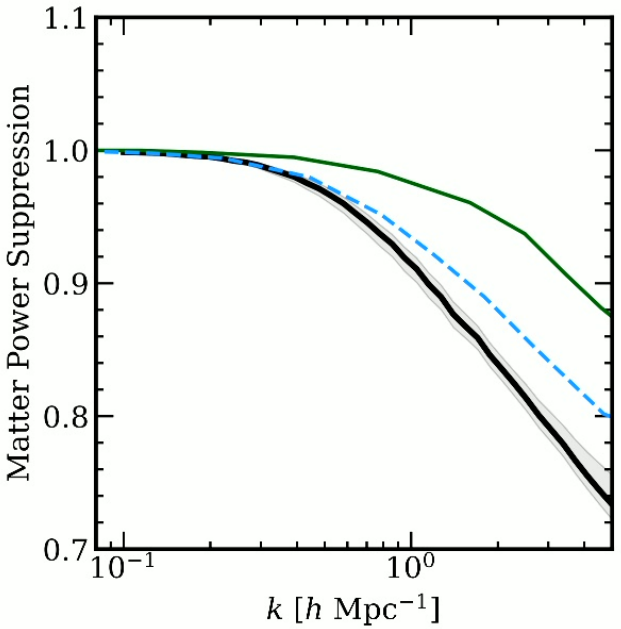

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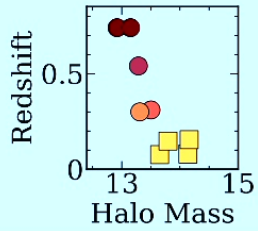

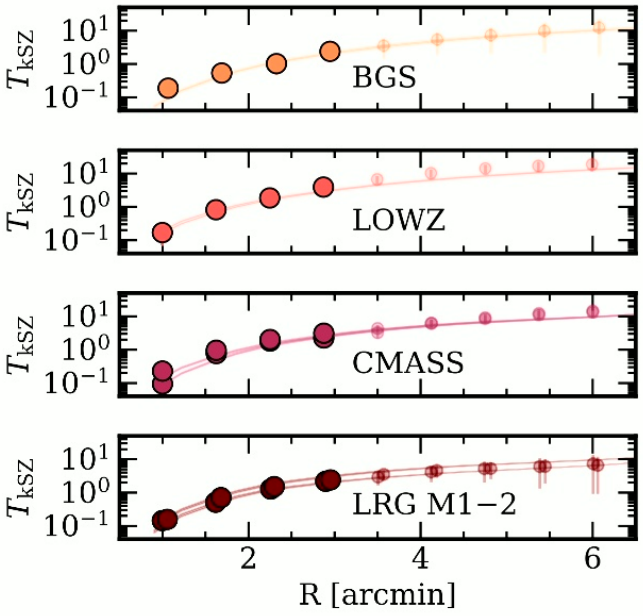

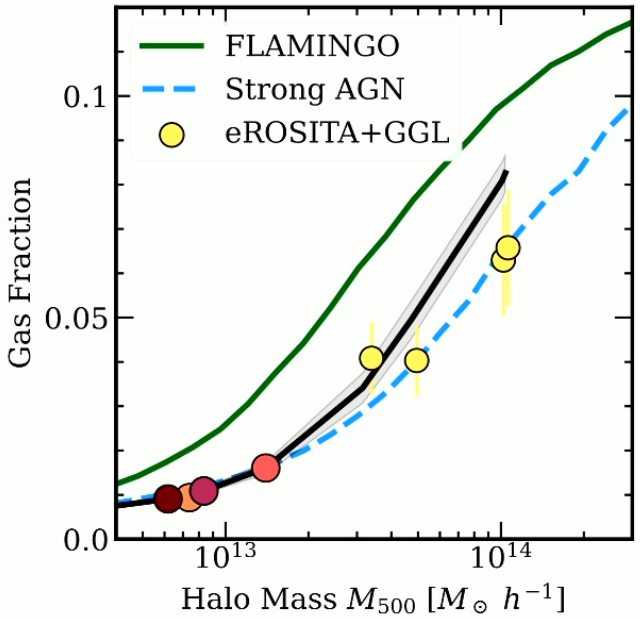

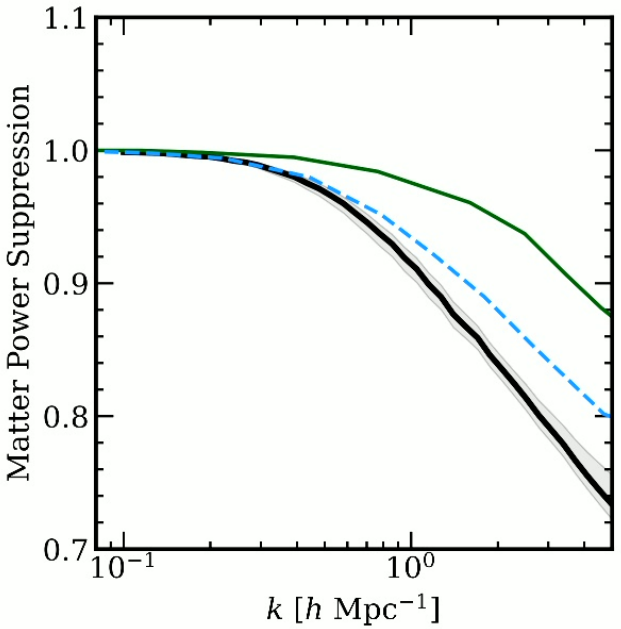

X-ray gas fractions **and** kSZ are consistent with extreme gas depletion

Siegel, Amon, McCarthy+

Data-driven priors for cosmic shear

Insights into the physics of feedback

Joint modeling of redshift, mass, and scale

Study across hydo-simulations

Characterize kSZ and X-ray with GGL

Observations require stronger feedback than **any** fiducial modern simulation

Bigwood, Yamamoto, Siegel, Amon, McCarthy+