Title: Flash Talks - 1 min, 1 slide

Speakers:

Collection/Series: Cosmic Ecosystems

Subject: Cosmology

Date: July 29, 2025 - 4:25 PM

URL: https://pirsa.org/25070062

Abstract:

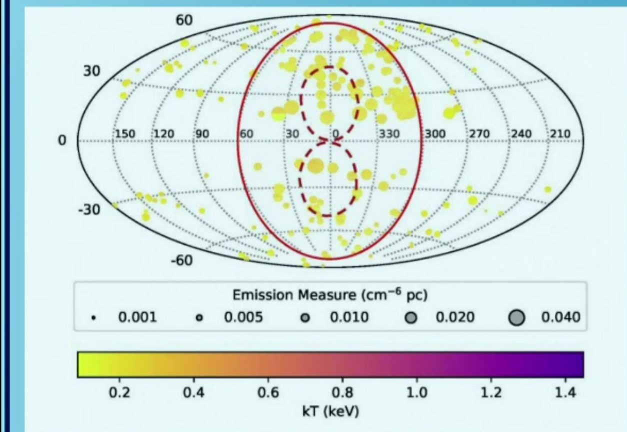
Presenters:

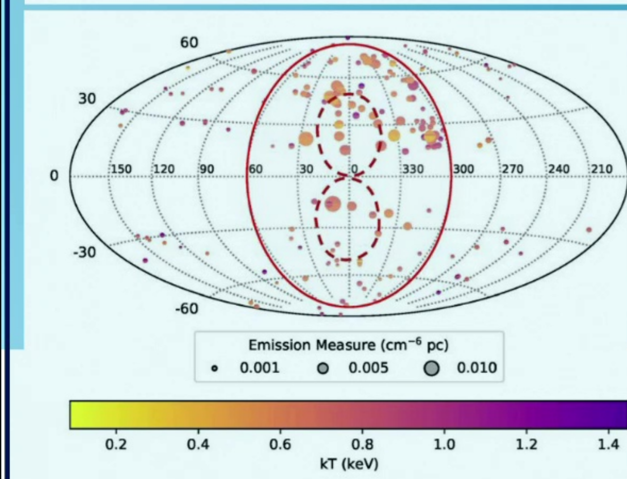
Anjali Gupta
Aromal Pathayappura
Brad Koplitz
Dazhi Zhou
Denis Leahy
Doga Tolgay
Ghazal Geshnizjani
Imran Sultan
James Sunseri
John Pharo
Manami Roy
Matthew Charbonneau
Natanael de Isídio
Simon Foreman
Smita Mathur
Syeda Lammim Ahad
Y. Samuel Lu
Yakov Faerman
Zhiyuan Yao

Milky Way CGM X-ray Emission: All Sky Survey and Shadow Observations

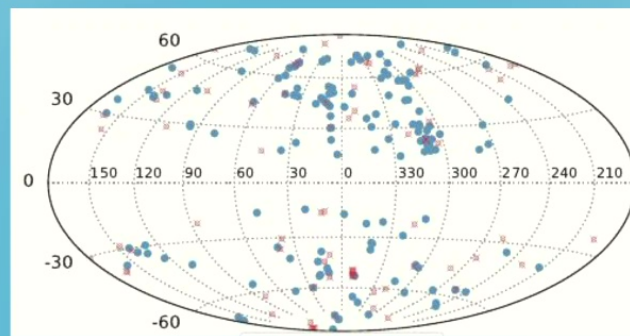
Anjali Gupta

Thermal Structure

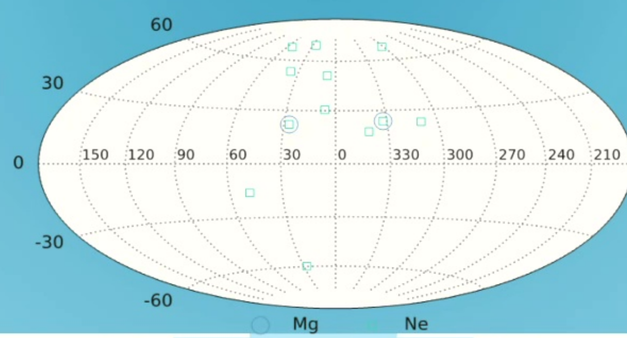




Chemical Signatures

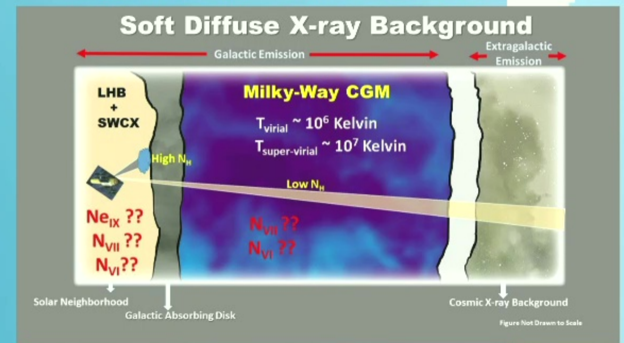


Widespread Super-solar N/O



Bubbles Super-solar Ne/O & Mg/O

Shadow Observations



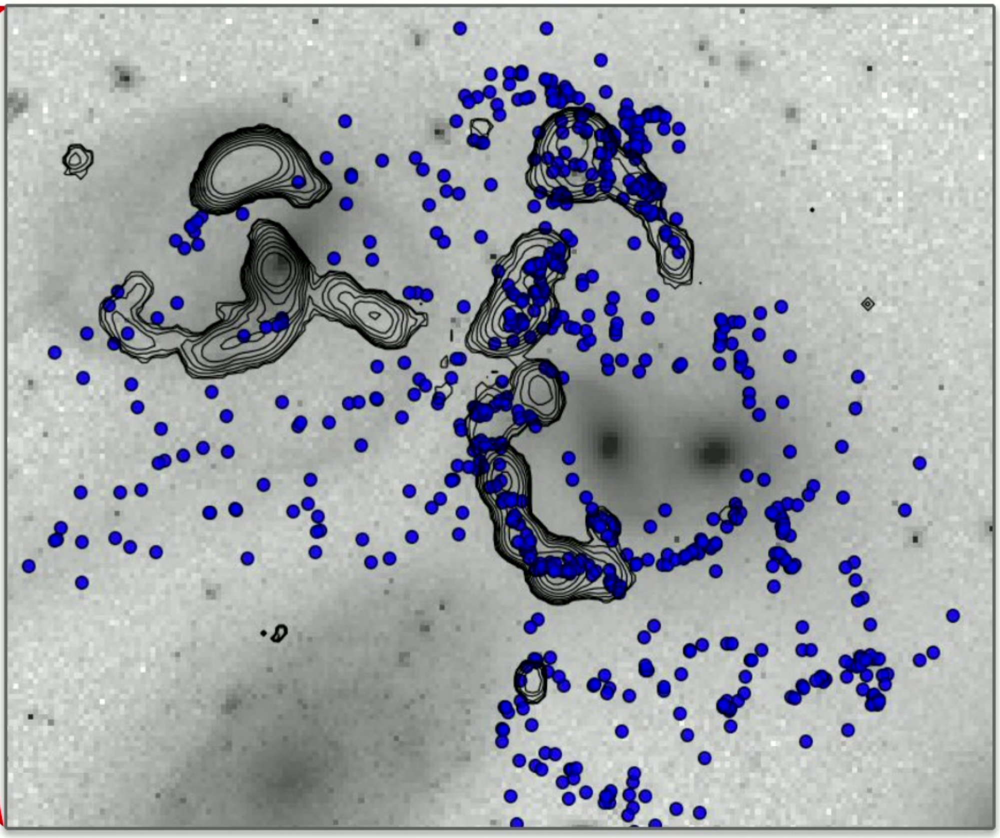
Confirmed All Sky Results

Results

- Widespread Super-Virial Gas in the Milky Way CGM
- Layered Feedback in the Milky way CGM: N/O, Ne/O & Mg/O as Chemical Choronometers

- Gupta, Mathur et al. 2023, Nature Astronomy, 7, 799
- Gupta, Mathur et al. 2025, arXiv:2507.13331

Active star formation in the intra-group medium of Stephan's Quintet

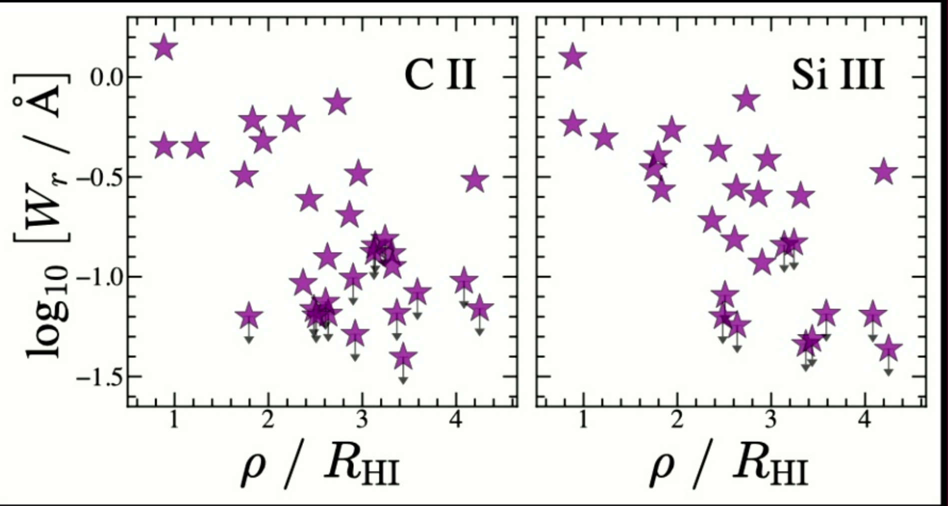


Aromal Pathayappura
E-mail : apathaya@uwo.ca

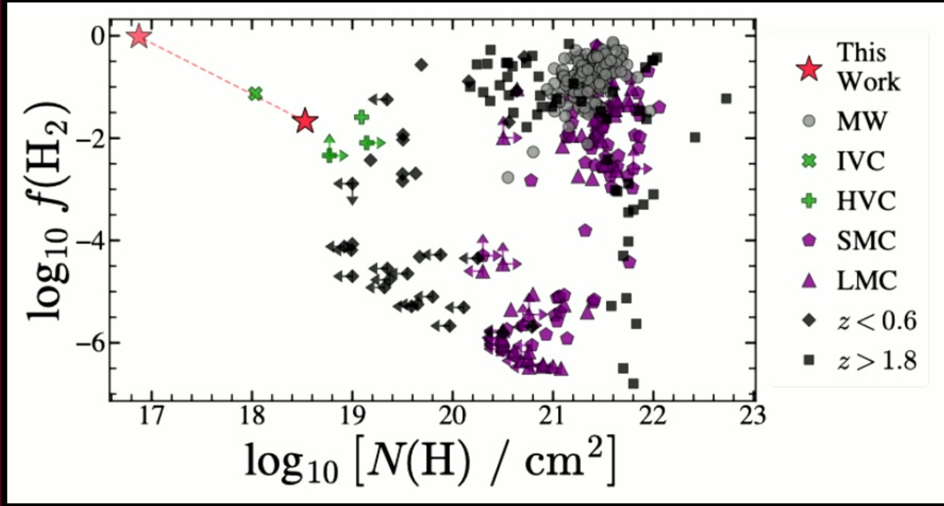
Metals (and H_2) in the Circumgalactic Medium of Low Redshift Galaxies

Brad Koplitz

ρ / R_{HI} Traces CGM Absorbers Better Than ρ / R_{vir}



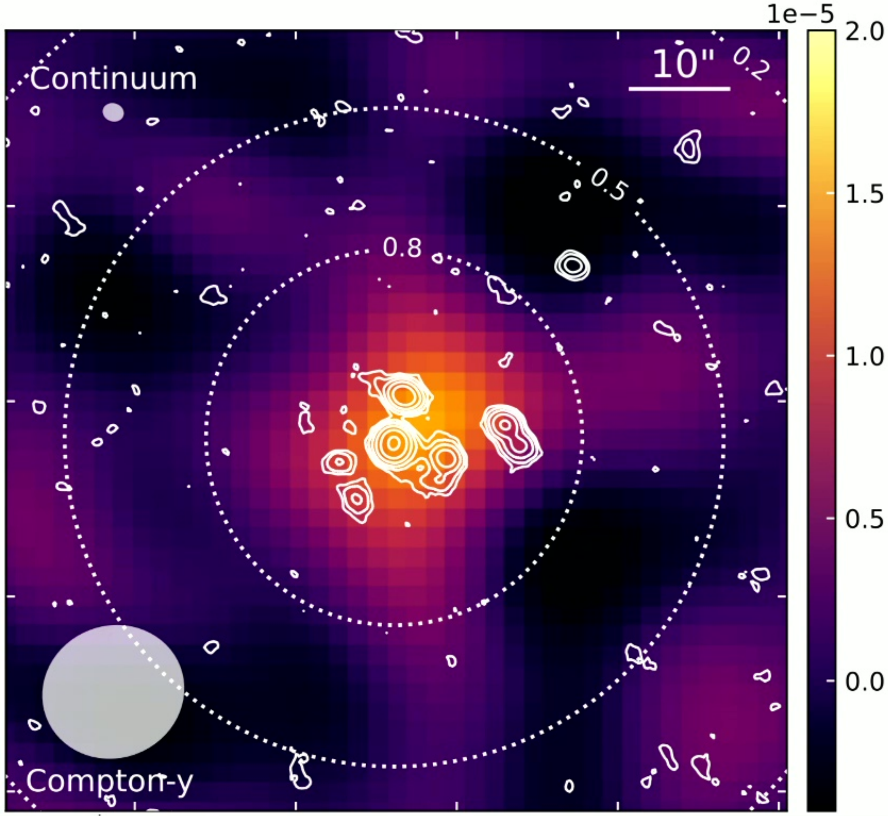
H_2 (Along with 12 Metals) in CGM at 139 kpc

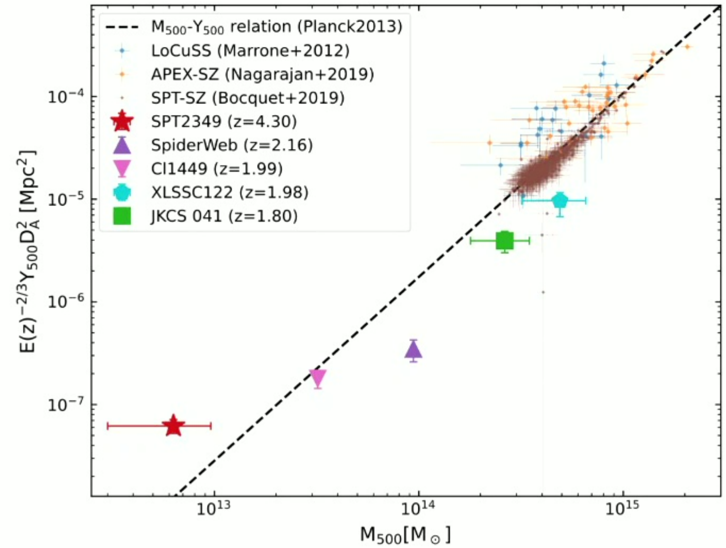


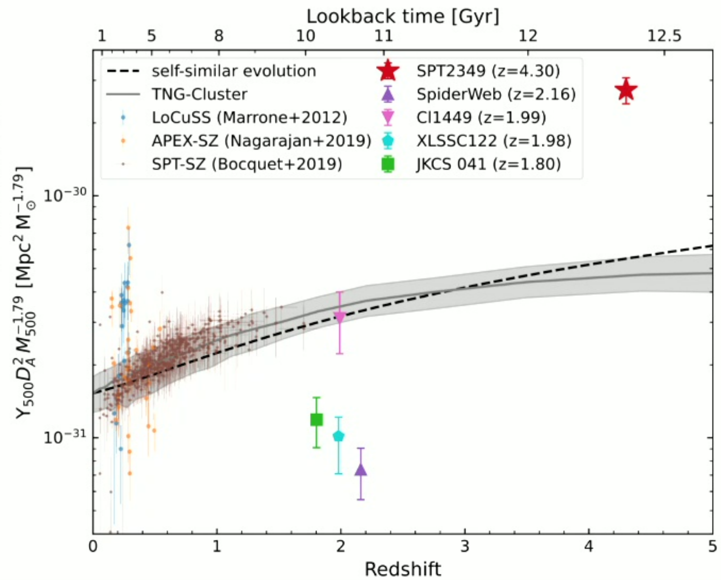
A large thermal energy reservoir in the nascent ICM at z=4.3

- A ~ 10σ tSZ detection in the protocluster SPT2349-56
- ~ 5 times stronger than the self-similar expectation

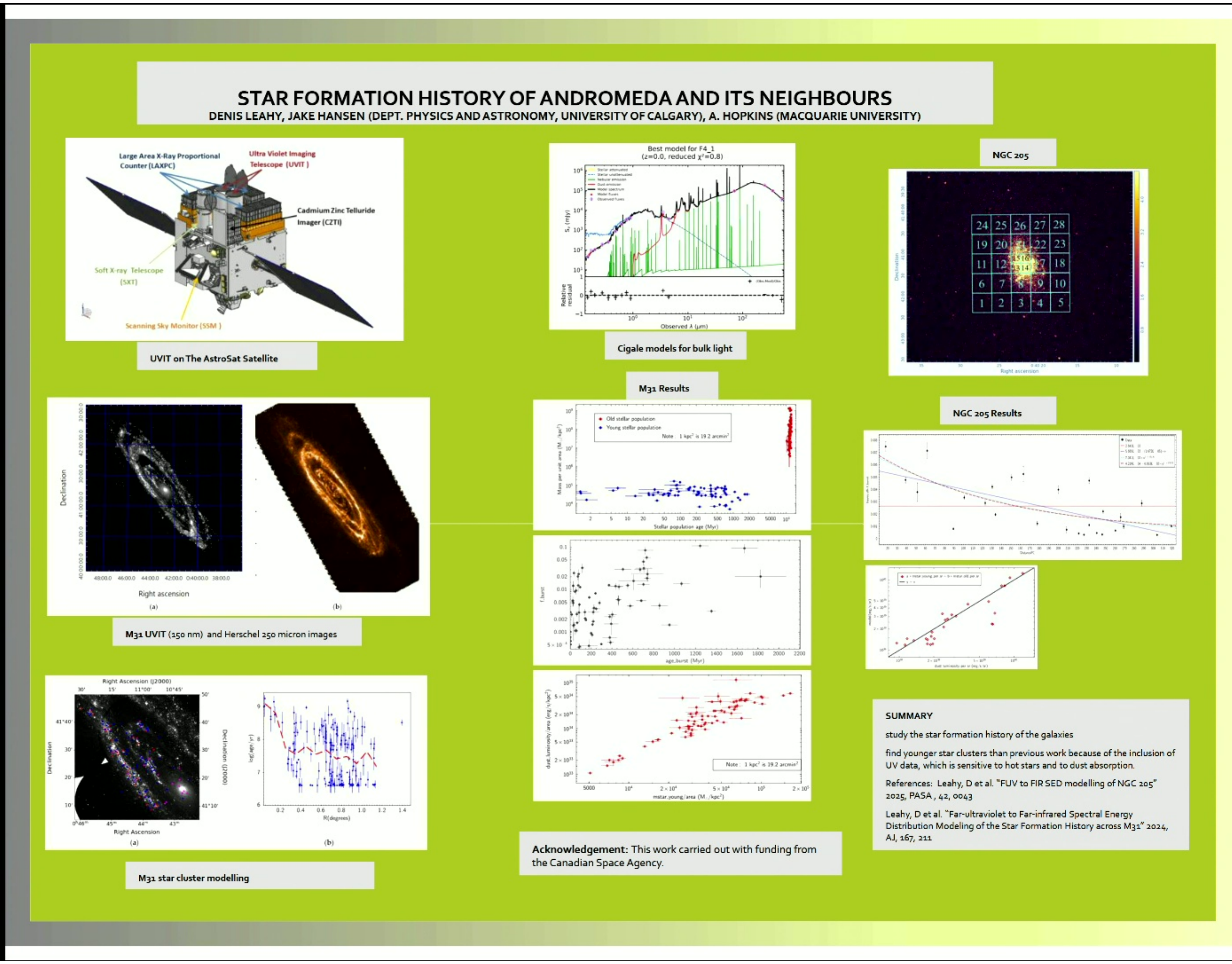
Please check my poster or scan the QR code for more information

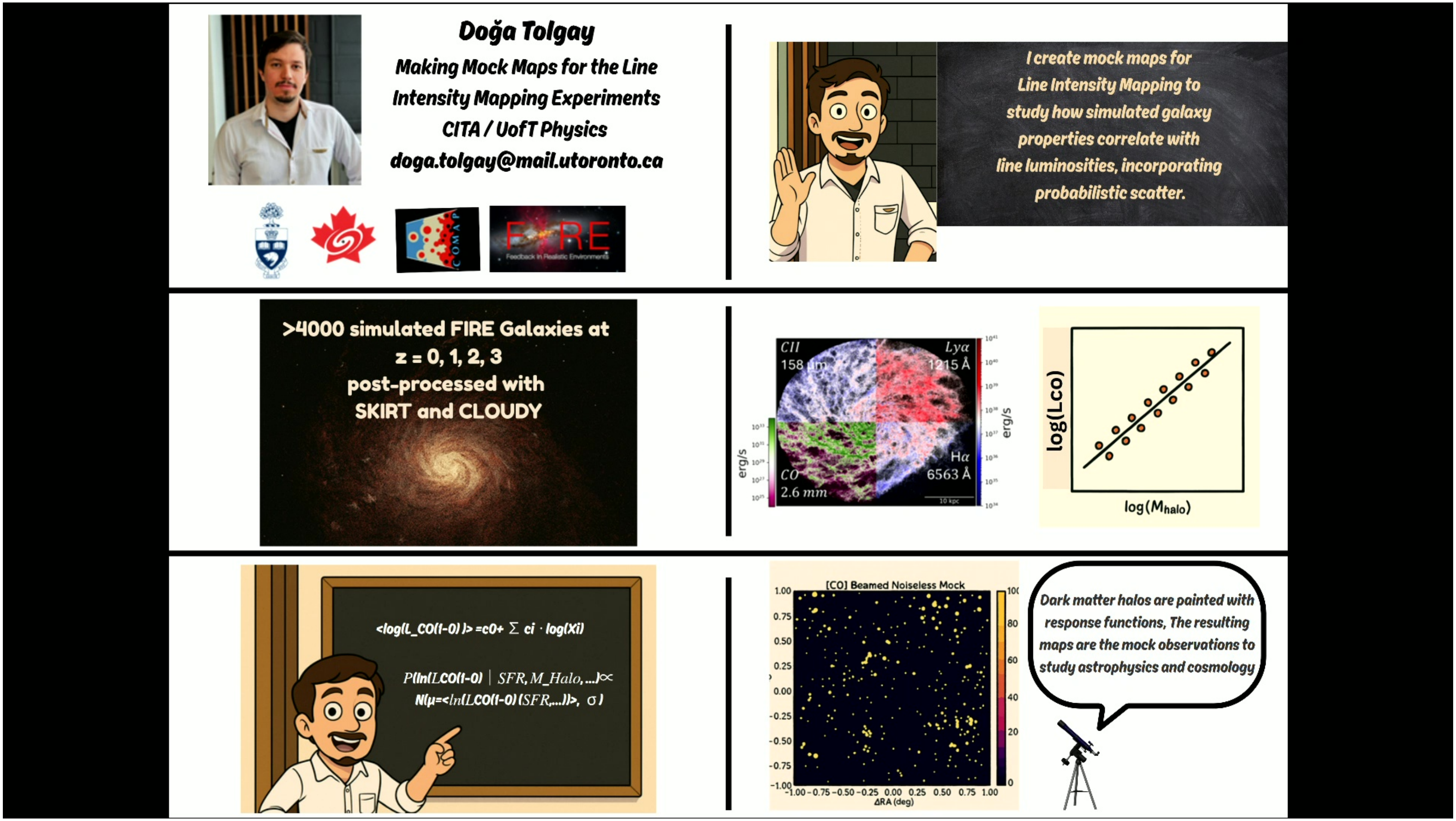






Dazhi Zhou,
Scott Chapman,
and SPT-SMG collaborations
The University of British Columbia
dzhou@astro.ubc.ca


STAR FORMATION HISTORY OF ANDROMEDA AND ITS NEIGHBOURS
DENIS LEAHY, JAKE HANSEN (DEPT. PHYSICS AND ASTRONOMY, UNIVERSITY OF CALGARY), A. HOPKINS (MACQUARIE UNIVERSITY)
Large Area X-Ray Proportional Counter (LAXPC)
Ultra Violet Imaging Telescope (UVIT)
Cadmium Zinc Telluride Imager (CZTI)
Soft X-ray Telescope (SXT)
Scanning Sky Monitor (SSM)
UVIT on The AstroSat Satellite
Best model for F4_1
Cigale models for bulk light
NGC 205
M31 Results
NGC 205 Results
M31 UVIT (150 nm) and Herschel 250 micron images
M31 star cluster modelling
Acknowledgement: This work carried out with funding from the Canadian Space Agency.
SUMMARY
study the star formation history of the galaxies
find younger star clusters than previous work because of the inclusion of UV data, which is sensitive to hot stars and to dust absorption.
References: Leahy, D et al. "FUV to FIR SED modelling of NGC 205" 2025, PASA , 42, 0043
Leahy, D et al. "Far-ultraviolet to Far-infrared Spectral Energy Distribution Modeling of the Star Formation History across M31" 2024, AJ, 167, 211


Doğa Tolgay
Making Mock Maps for the Line Intensity Mapping Experiments
CITA / UofT Physics
doga.tolgay@mail.utoronto.ca
I create mock maps for Line Intensity Mapping to study how simulated galaxy properties correlate with line luminosities, incorporating probabilistic scatter.
>4000 simulated FIRE Galaxies at z = 0, 1, 2, 3 post-processed with SKIRT and CLOUDY
CII 158 μm
Lyα 1215 Å
CO 2.6 mm
Hα 6563 Å
erg/s
log(Lco)
log(Mhalo)
<log(L_CO(1-0))> =c0+ Σ ci · log(Xi)
P(ln(LCO(1-0) | SFR, M_Halo,...)∝ N(μ=<ln(LCO(1-0)(SFR,...))>, σ)
[CO] Beamed Noiseless Mock
ΔRA (deg)
Dark matter halos are painted with response functions, The resulting maps are the mock observations to study astrophysics and cosmology

How Much NEC Breaking Can the Universe Endure?

Ghazal Geshnizjani, Brayden Hull, Elly Moghtaderi and Jerome Quintin e-Print: 2503.19955 [gr-qc], Phys. Rev. D 111, 123552 (2025)

Classical Energy Conditions in Classical GR:

Energy conditions → guidelines for **'reasonable'** matter and energy central to **singularity theorems**

(Strong Energy Condition violated for Inflation or Dark Energy)

Null Energy Condition (NEC $\Longrightarrow R_{\mu\nu}K^\mu K^\nu \geq 0$): $T_{\mu\nu}K^\mu K^\nu \geq 0 \quad \forall K^\mu$ null .

General relativity: $G_{\mu\nu} = 8\pi G_N T_{\mu\nu}$

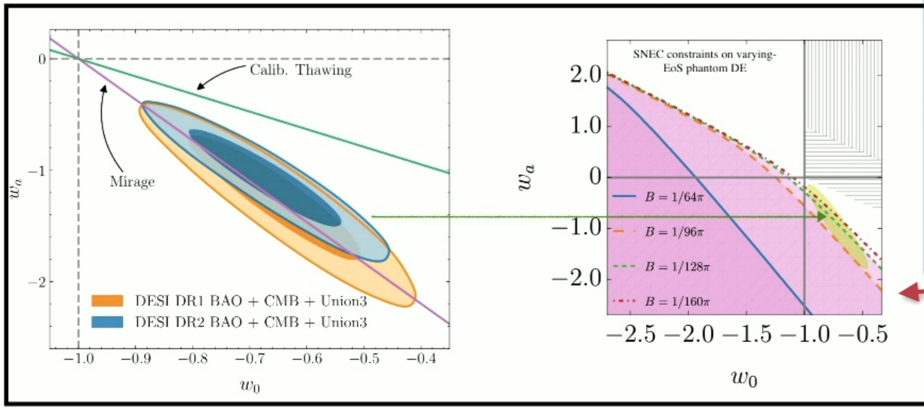
NEC Violations in Quantum Contexts:

Quantum fields can violate the NEC locally (Casimir effect, etc.).

$$\langle \hat{T}_{\mu\nu}\rangle \equiv \langle \Psi | \hat{T}_{\mu\nu} | \Psi \rangle \ \exists\ |\Psi\rangle; \quad \langle \Psi | \hat{T}_{\mu\nu} K^\mu K^\nu | \Psi \rangle < 0$$

Semiclassical Gravity: $G_{\mu\nu} = 8\pi G_N \langle \hat{T}_{\mu\nu}\rangle \Longrightarrow R_{\mu\nu}K^\mu K^\nu \leq 0$

Smeared NEC Constraints on Dark Energy



Smeared Null Energy Condition (SNEC):

- **Non Local Energy conditions:** Limit in semiclasssical gravity to how much **'negative energy'** can accumulate from quantum effects (Ex: ANEC, QI, … Ford and Roman :1994, Flanagan:1997, …)
- **SNEC** (Freivogel and Krommydas 2018, Freivogel, Kontou and Krommydas 2022):
  Along Null geodesics using smearing function $f_\tau^2(\lambda)$ and an smearing scale τ

$$\mathbb{E}_\tau[F] \equiv \int_\gamma d\lambda\, f_\tau^2(\lambda) F(\lambda)\,, \quad \int_\gamma d\lambda\, f_\tau^2(\lambda) = 1, \quad \frac{1}{\tau^2} \equiv 4\int_\gamma d\lambda \left(\frac{df_\tau}{d\lambda}\right)^2.$$

$$\mathbb{E}_\tau\left[\langle \Psi | \hat{T}_{\mu\nu} K^\mu K^\nu | \Psi \rangle\right] \geq -\frac{B}{G_N \tau^2}$$

- **SNEC on Dark Energy:**
  Assuming perfect fluid, FLRW space time and $T^I_{\mu\nu} = \langle \hat{T}^I_{\mu\nu}\rangle, \quad \lambda \leftrightarrow a, \quad \tau \leftrightarrow \Delta a$

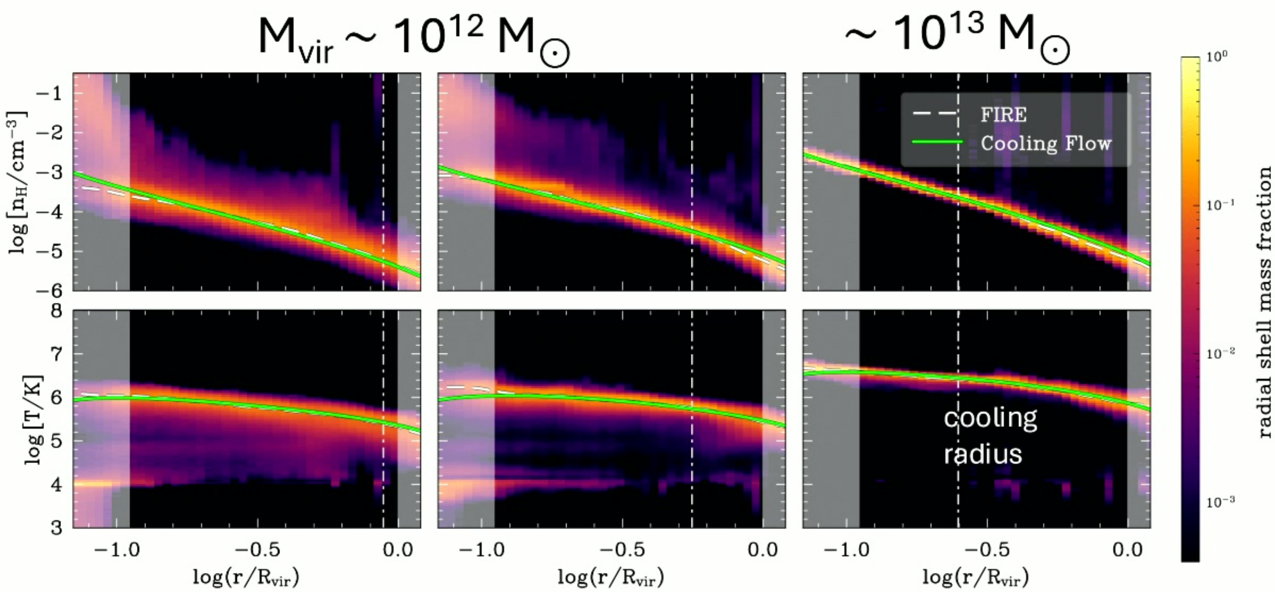
$$\int_{a_i}^{a_f} \frac{da}{H(a)}\, f_\tau^2(\lambda(a)) \frac{\rho_{DE}(a) + p_{DE}(a)}{a^2} \geq -\frac{B}{G_N \tau^2}.$$

and $w(a) = w_0 + w_a(1 - a)$

PERIMETER INSTITUTE

Cooling Flows as a Reference Solution for the Hot Circumgalactic Medium

Imran Sultan with Claude-André Faucher-Giguère, Jonathan Stern,
Shaked Rotshtein, Lindsey Byrne, Nastasha Wijers, and the FIRE Collaboration



We use **idealized cooling flow models to study the hot CGM** in Milky Way-mass and $\sim 10^{13}\,M_\odot$ FIRE halos in the absence of AGN feedback.

Cooling flows predict thermodynamic profiles of *n, T, K* broadly consistent with the hot CGM in FIRE, and reproduce entropy profiles better than other idealized models.

Sultan et al.
2025 (MNRAS)

sultan@u.northwestern.edu

James Sunseri

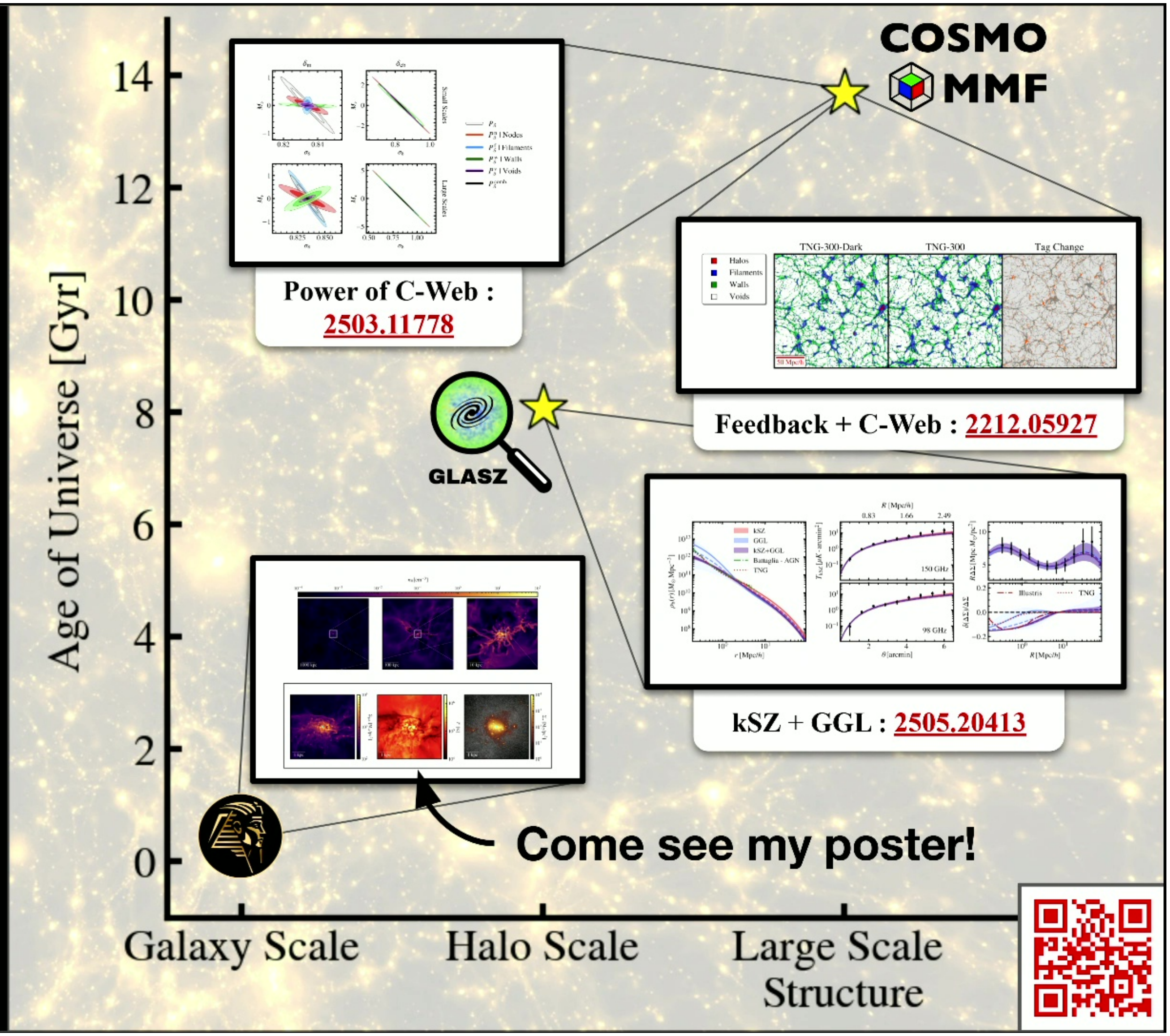
PhD Student - Y3

Advisors
Romain Teyssier
Alexandra Amon

I use cosmological simulations, CMB secondaries, and weak lensing to study baryonic feedback across many scales and cosmic time

I like building codes for others to use

- **`pycosmommf`**: cosmic web identification
- **`glasz`**: Joint model for kSZ + GGL

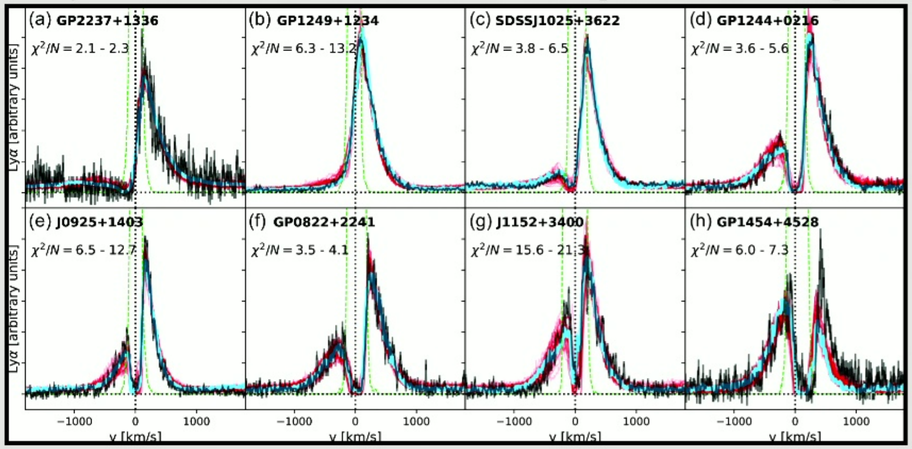


What Shapes the Distribution of Lyα Spectra?

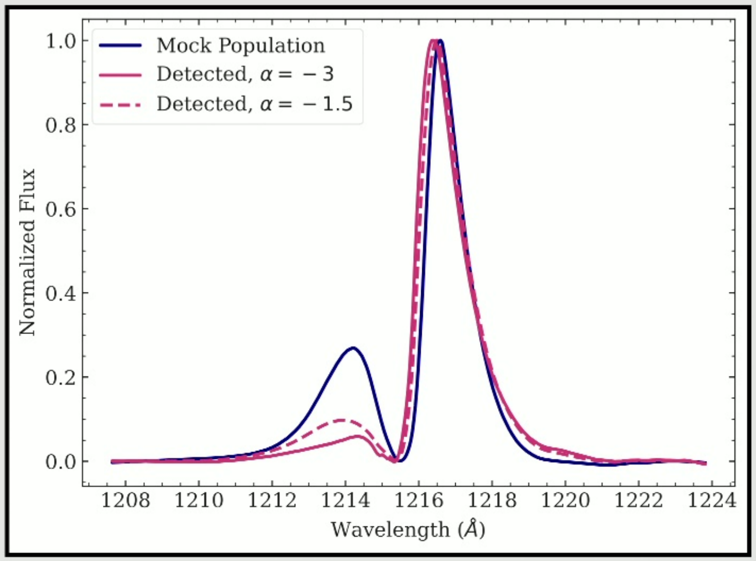
John Pharo

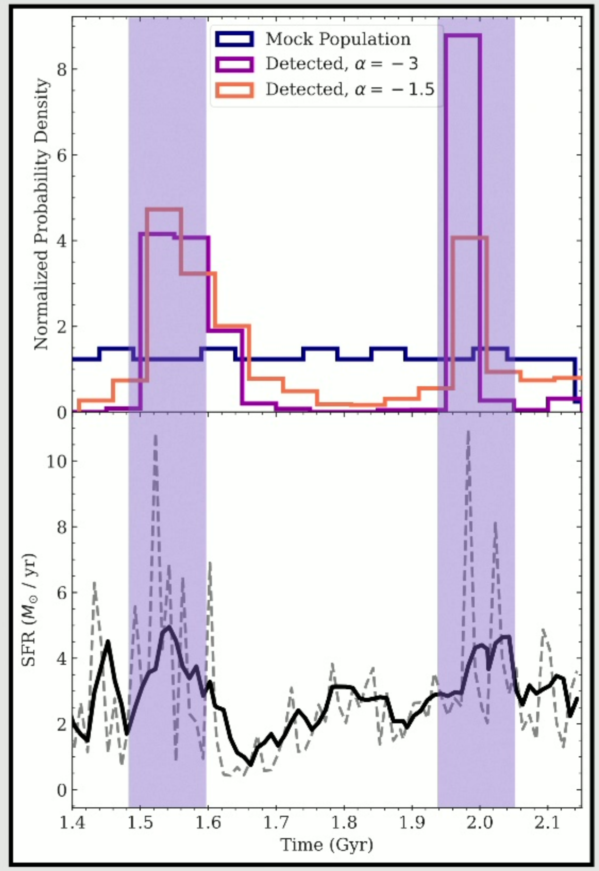
AIP

1) Lyα emission has diverse spectral shapes



2) Using simulated spectra, we test which spectral shapes are more easily detected with a model selection function



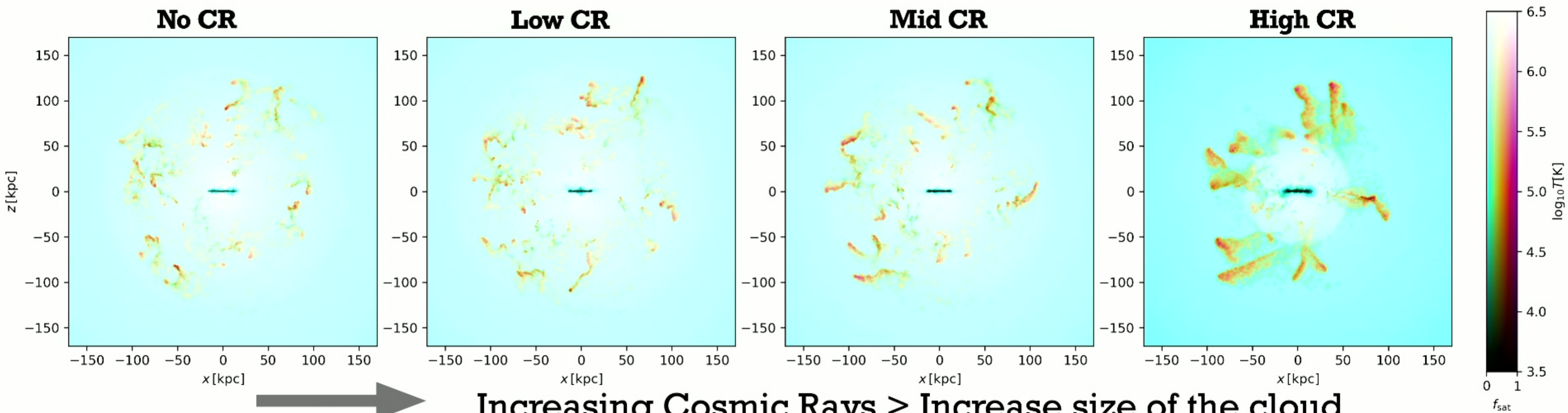


Read the first paper: arXiv 2409.04537

3) Detected spectra preferentially come from time steps with peak SFR and outflows

To Survive or to Shatter: Cosmic Rays Decide the Fate of Stripped Cold Clouds

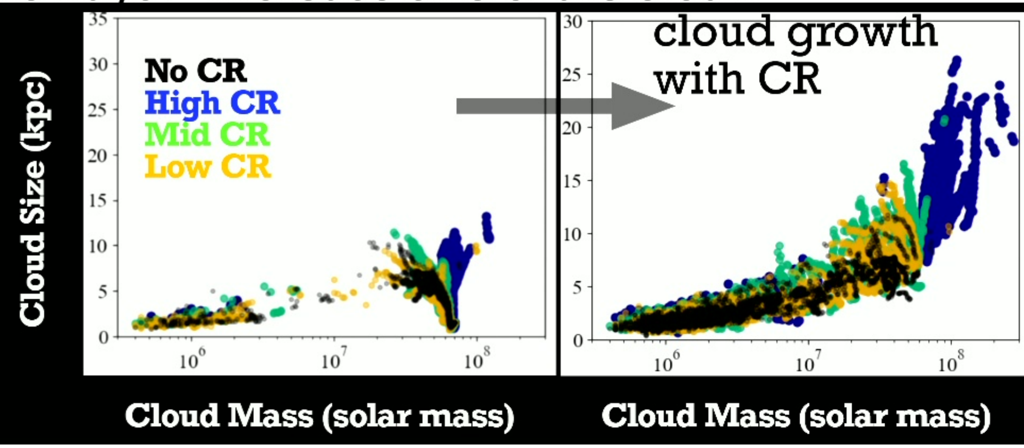
Manami Roy* (CCAPP Fellow, OSU), Kung-Yi Su, Stephanie Tonnesen



Increasing Cosmic Rays > Increase size of the cloud

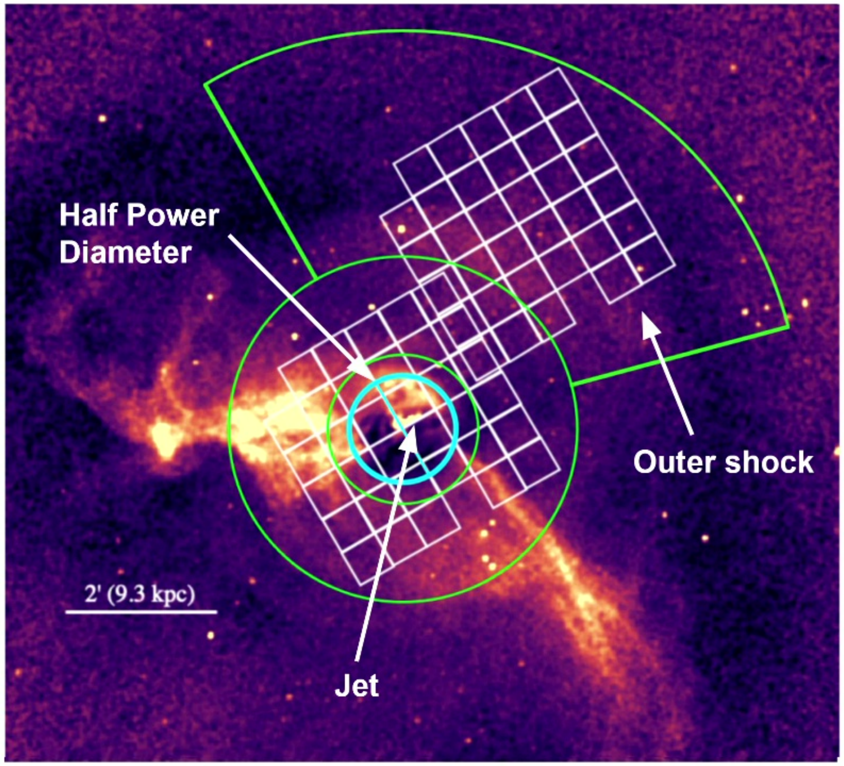
1. *GIZMO, FIRE-2 Feedback*
2. *MW-like host*
3. *20 identical $10^9\ M_{solar}$ satellites*

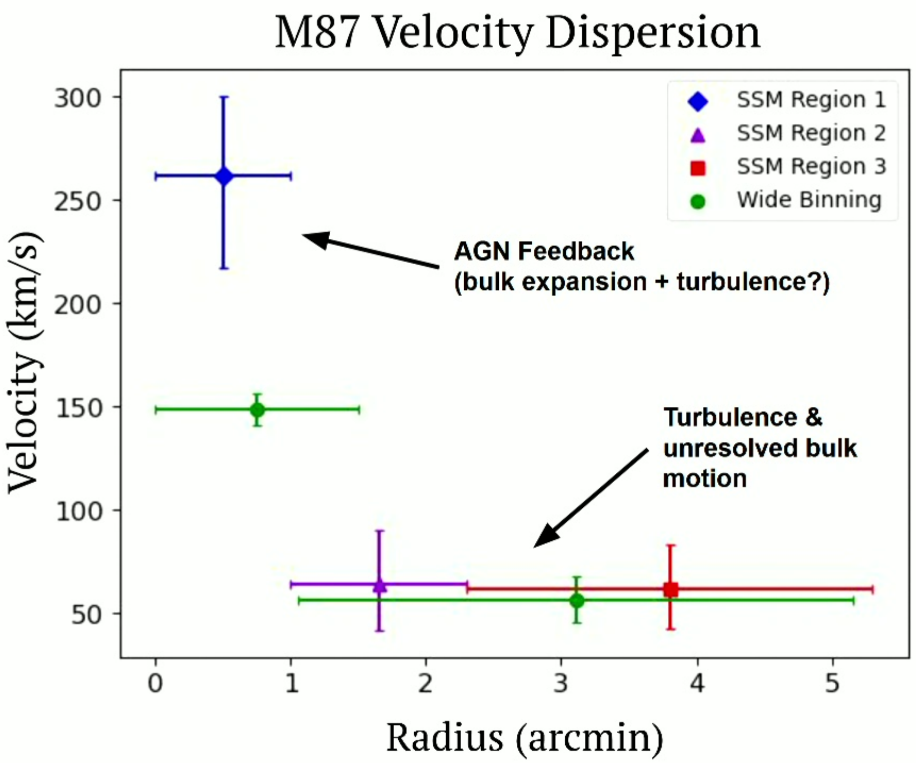
CR increases cold gas covering fraction & influx, which can feed the host galaxy the cold gas required to sustain SFR.



Measuring the AGN-Driven X-ray Atmosphere Kinematics of M87 using XRISM/Resolve

Matthew Charbonneau | m3charbo@uwaterloo.ca | University of Waterloo



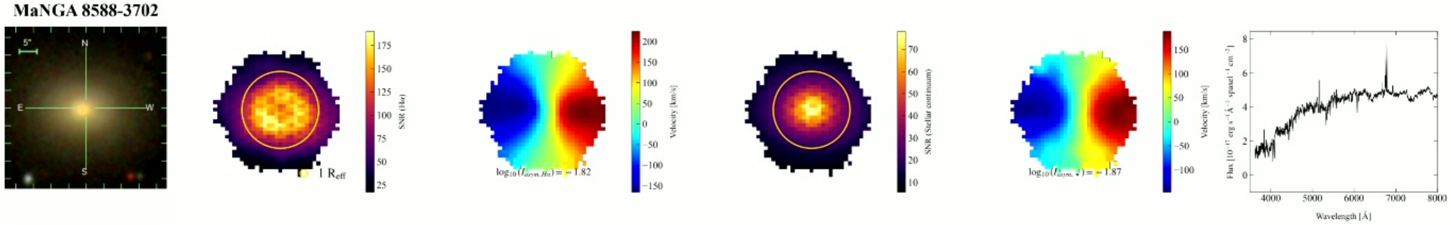


Work in preparation — XRISM Collaboration (corr. authors: H. McCall, A. Simionescu, C. Kilbourne)

The kinematic imprinting of environmental quenching

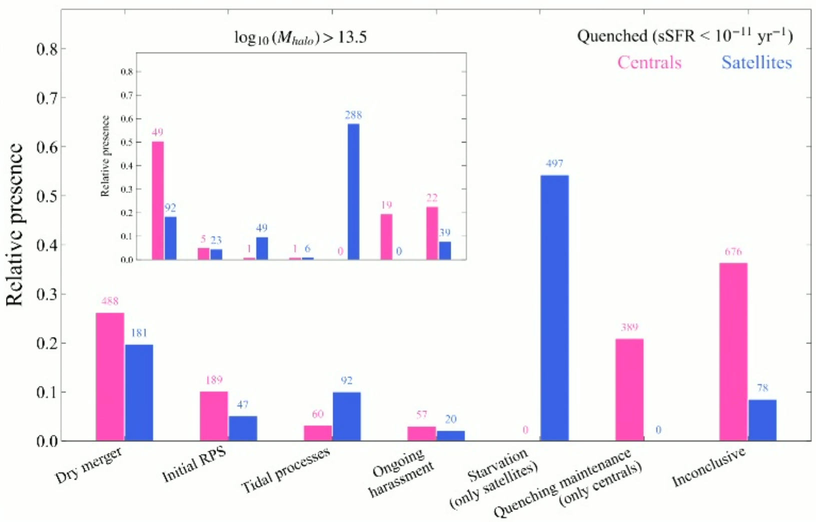
Natan de Isídio (ESO, Germany)

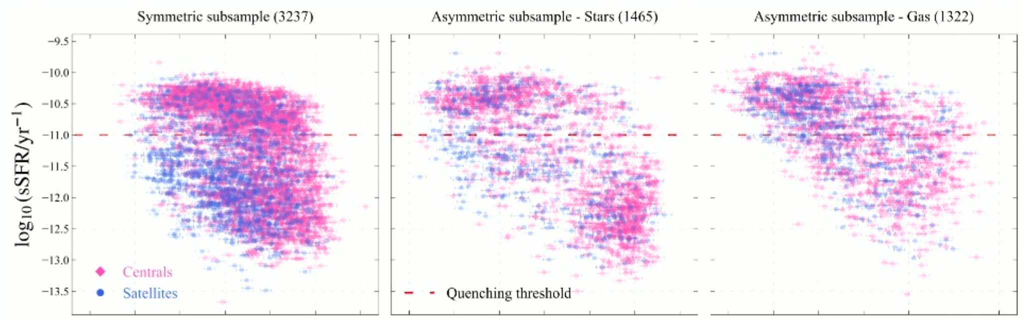
de Isídio et al. 2025a (TBS)
de Isídio et al. 2025b (in prep.)



Multi-wavelength approach: X-rays, Optical, IR, and Radio

Quantifying the relative contributions of various physical mechanisms to galaxy quenching



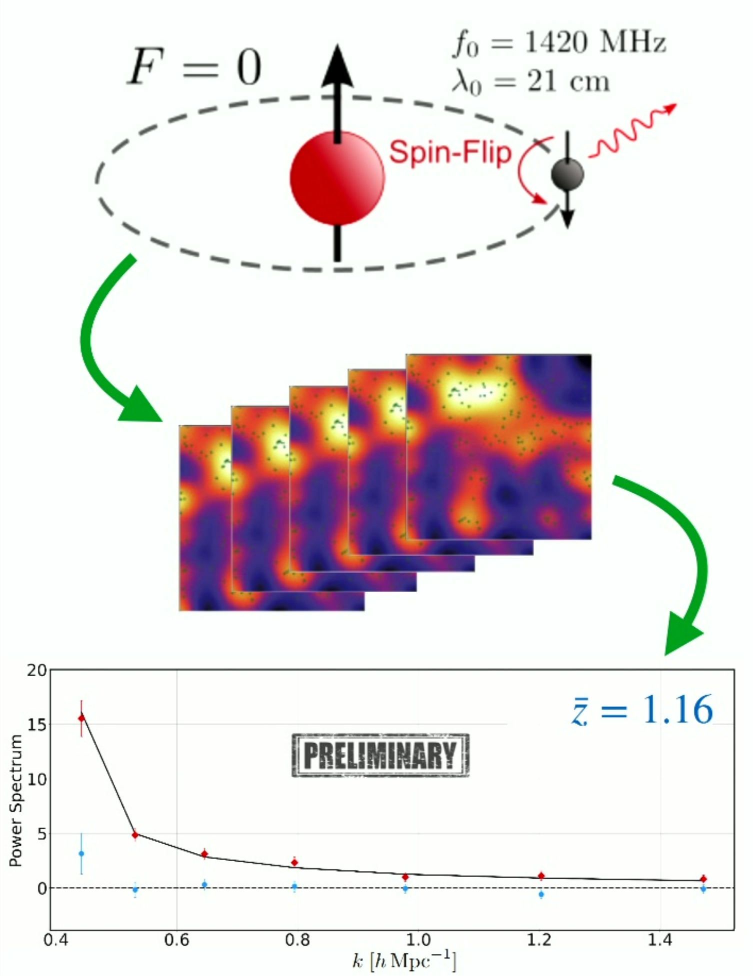


State-of-the-art simulations: TNG50 & Magneticum

Natanael.Isidio@eso.org | *Galaxy Ecosystems* | Perimeter Institute, Canada

Probing HI with 21cm Intensity Mapping

Simon Foreman, *Arizona State University*



What can we learn?

- Small-scale HI clustering
- Galaxy-HI connection
- IGM-HI connection
- Cosmic HI density $\Omega_{\mathrm{HI}}(z)$
- Linear HI bias $b_{\mathrm{HI}}(z)$ (and higher-order biases)
- HI velocity dispersion (via Fingers of God)

Open questions:

- Measurements → models of cosmic ecosystems?
- Do we have the necessary theory/simulations?
- Combine with other observational probes?

See poster for more!

Where the bayons reside……Comprehensive understanding of the hot circumgalactic medium

Milky Way CGM:
Absorption, Emission

Mathur, Das, Gupta, Roy, Krongold, Lara-DI, ….

eROSITA Bubbles, All Sky Survey

Gupta, Mathur, Das ….

Theory/Simulations

Roy, Bisht, Nath, Mathur, Das, Runger….

https://doi.org/10.1007/978-981-16-4544-0_112-1

External galaxies:
Absorption, Emission

Das, Mathur, Gupta, Krongold….

tSZ : A complementary alternative to X-ray observations

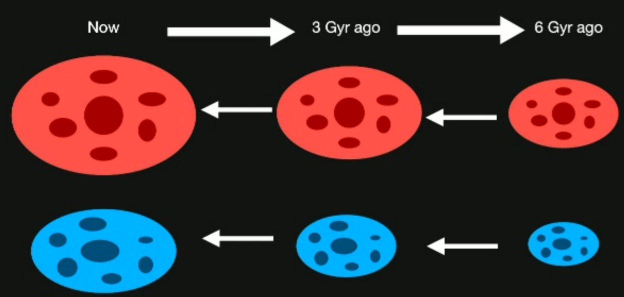
Das, Mathur….

Cosmic Ecosystems 2025, PI, Waterloo

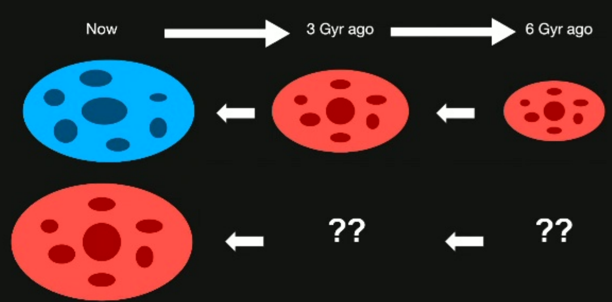
Uncovering the Growth History of the Largest Cosmic Structures

Syeda Lammim Ahad
WCA Postdoctoral Fellow
WATERLOO CENTRE FOR ASTROPHYSICS
UNIVERSITY OF WATERLOO

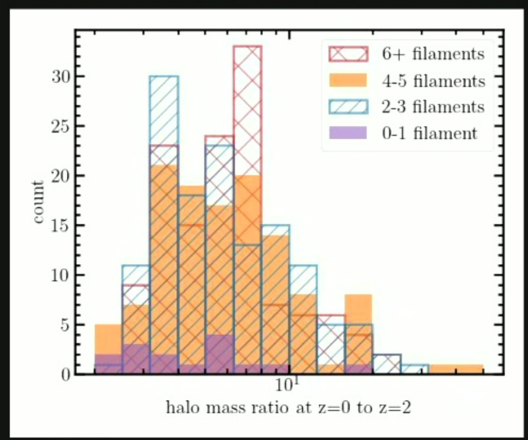
Cluster growth: expectation



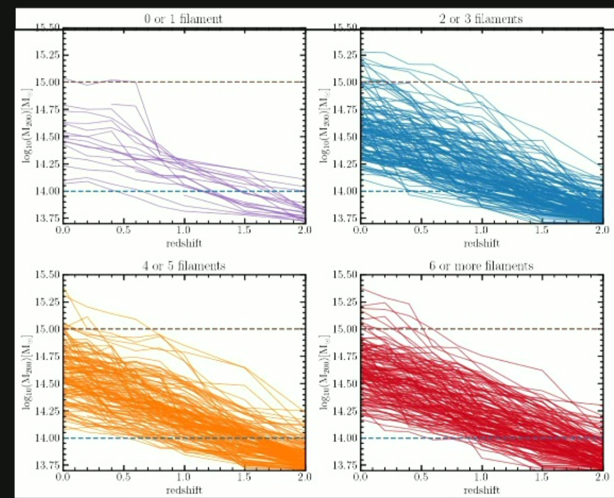
Cluster growth: reality??



What drives the growth of protoclusters?

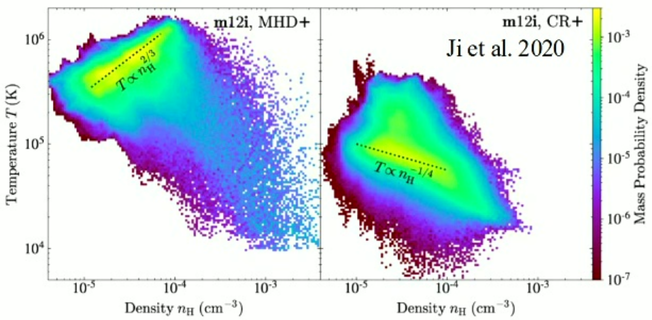


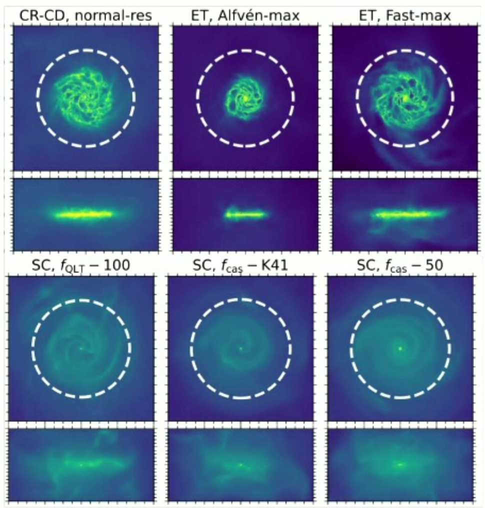
Data: FLAMINGO simulations



Filament connectivity is positively correlated to the cluster growth, except for when it is the most efficient!

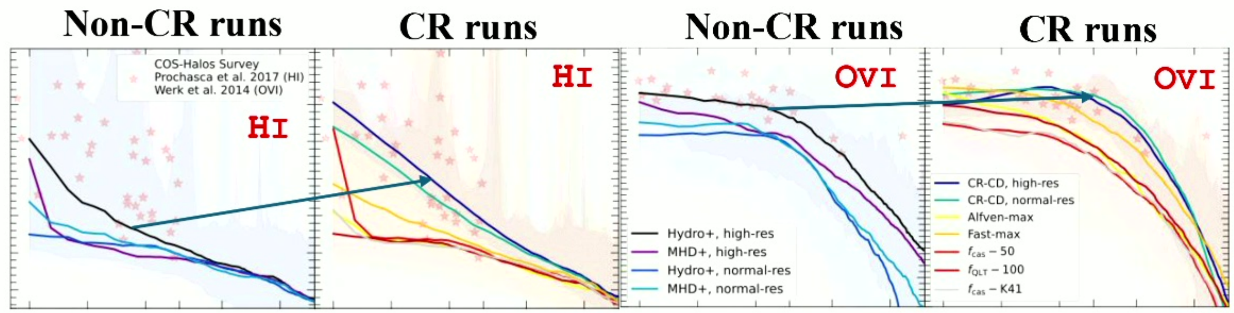
- Y. Samuel Lu: rising 4th year PhD from UCSD, working with Dušan Kereš
- I am interested in non-thermal processes in galaxy formation/evolution, particularly the CR and B-fields
  - **CRs strongly affect CGM phase structures and properties/observables**
  - **CR transport models are unconstrained**



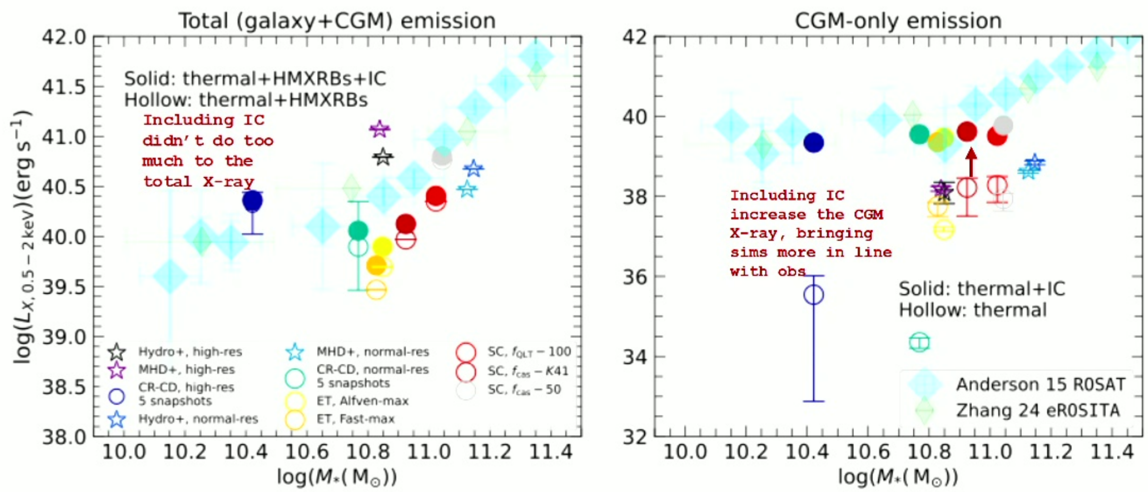


Different CR models produce very different galaxies in sims

- **We generated synthetic observations of ions (HI, OVI) and X-ray emission from FIRE galaxies, both with and without CRs**
- **We compared to observations (COS-Halos, ROSAT, and eROSITA)**

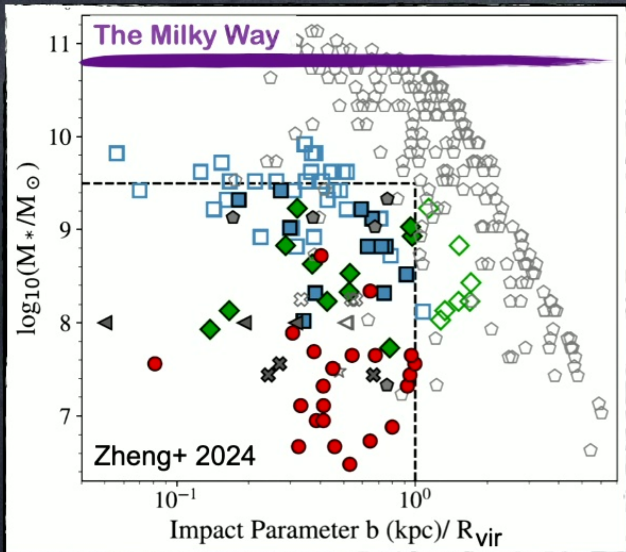


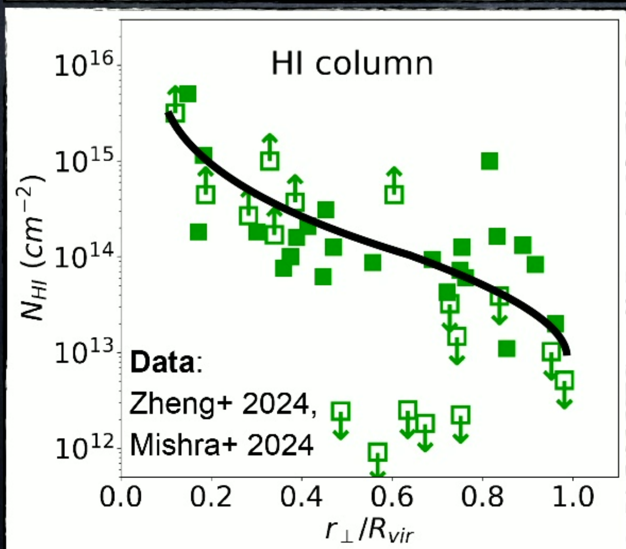
- **Overall, CRs <u>boost up</u> ion densities and <u>lower</u> thermal X-ray emission**
- **Total X-ray emission is dominated by thermal + XRBs, but the CGM X-ray comes largely from inverse Compton (IC) scatterings between CRe and CMB photons**



Cool CGM in low-mass galaxies

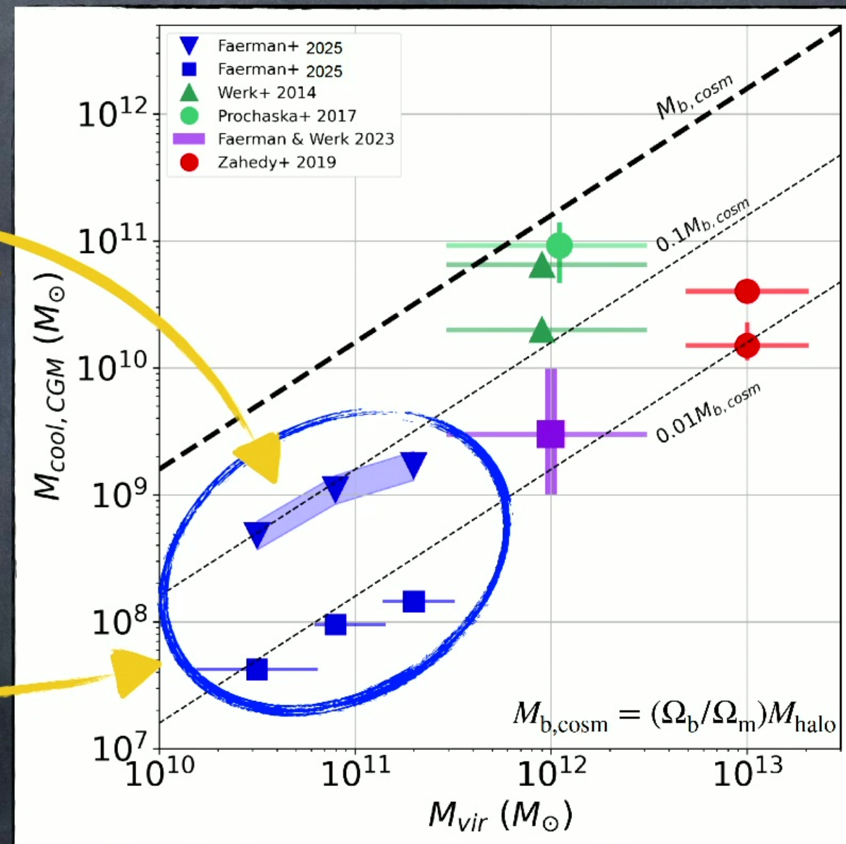
40 isolated galaxies at $z < 0.3$, HI absorption





>85% of the baryons are unaccounted for

Empirical model



Yakov Faerman (Tel Aviv University)

Cloud Geometry & Metallicity on Cold Gas Fragmentation, and Implications for **Cold Streams Penetrating Virial Shocks**

***Zhiyuan Yao (HUJI)*, N. Mandelker, S. P. Oh, H. Aung, A. Dekel**

DOI: 10.1093/mnras/stae2771

- **Goal**: understand cloud size and morphology in I/CGM
- **Method**: 3D idealized sims of thermal unstable clouds with three geometries and two Z
- **Results**: fragmentation: sphere>stream>sheet; low Z>high Z
- **Implications**: cold stream fragments while penetrating virial shocks at $z \gtrsim 2$, explaining large clumping factors & covering fractions of cold gas in observations