

From Simba-C to Athena: Mock X-ray Elemental Abundances in Galaxy Groups and Clusters

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A quick recap: The Simba-C Simulation

Gizmo + Simba + Chem5 = Simba-C¹



Base Simulation (Simba):

- Gizmo: Meshless-hydrodynamics, gravity, and thermal evolution.
- **Sub-grid:** Stellar and black-hole formation, feedback systems.



Chemical Enrichment (Chem5):^a

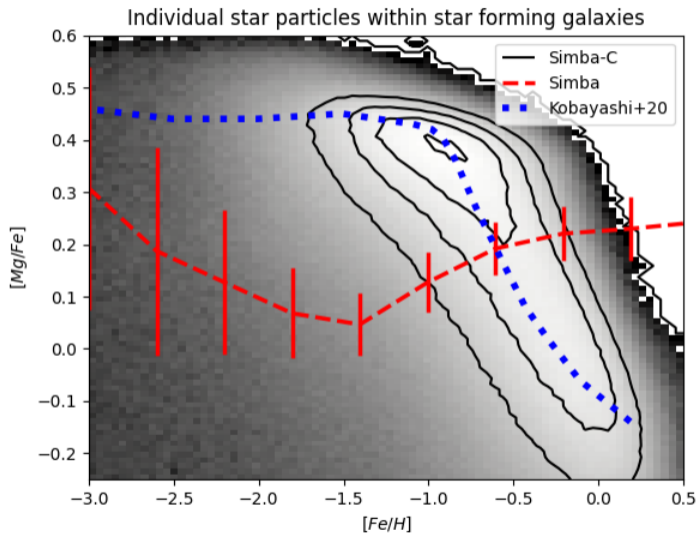
- 32 elements (H→Ge), treating stars as evolving populations.
- **Calibrations:** Chabrier IMF, dust mapping, $f_{\text{SNII}} = 0$, tuned wind/jet scaling.

^aKobayashi C., et al. (2007, 2011, 2020); Romano D. et al. (2005)

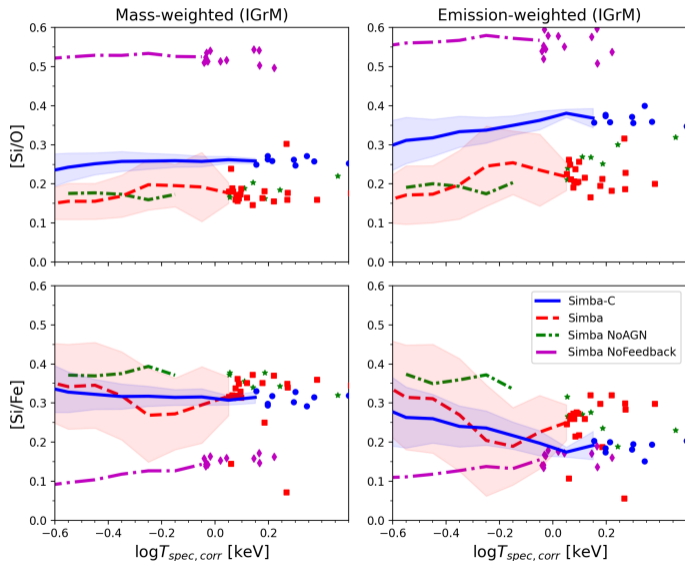
¹Davé et al. (2016, 2019); Hough R. T., et al. (2023)

So why do we want to make mock X-ray observations for Simba-C specifically?

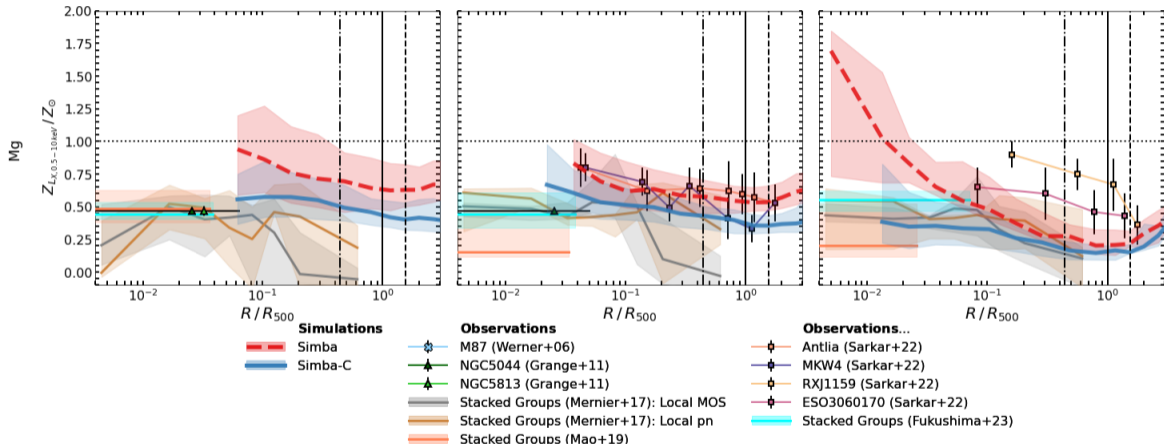
Galaxy $[Mg/Fe]$ abundance ratios



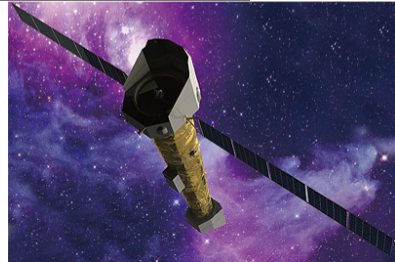
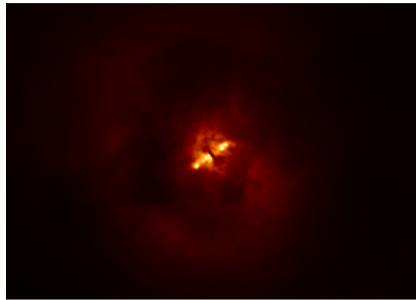
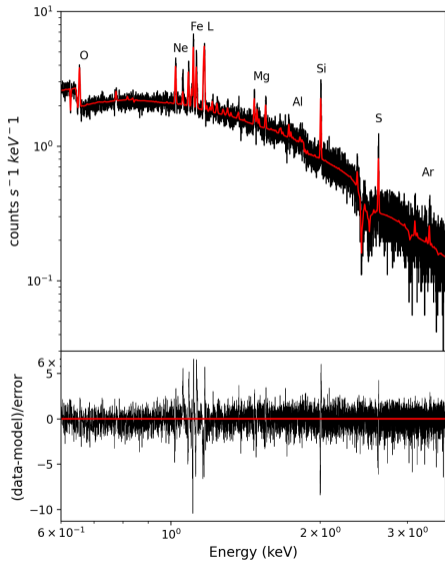
Galaxy group [Si/Fe] and [Si/O] abundance ratios

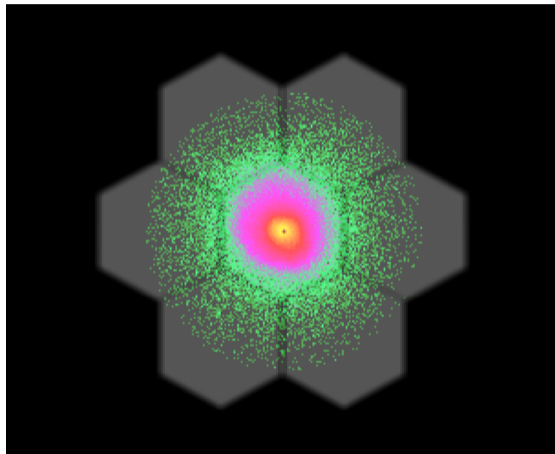
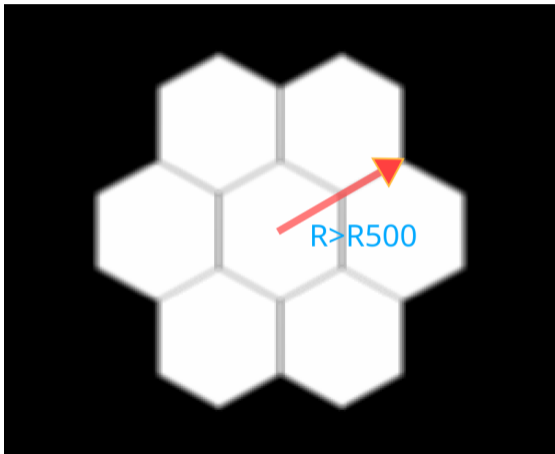


Group and cluster Mg profiles - Padawer-Blatt A., et al (2025)

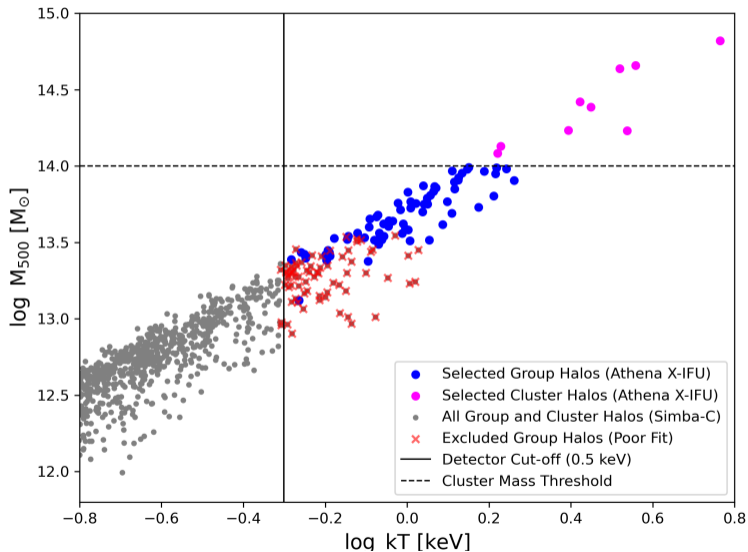


Mock Athena X-IFU observations (M_{Oxha}) - original idea

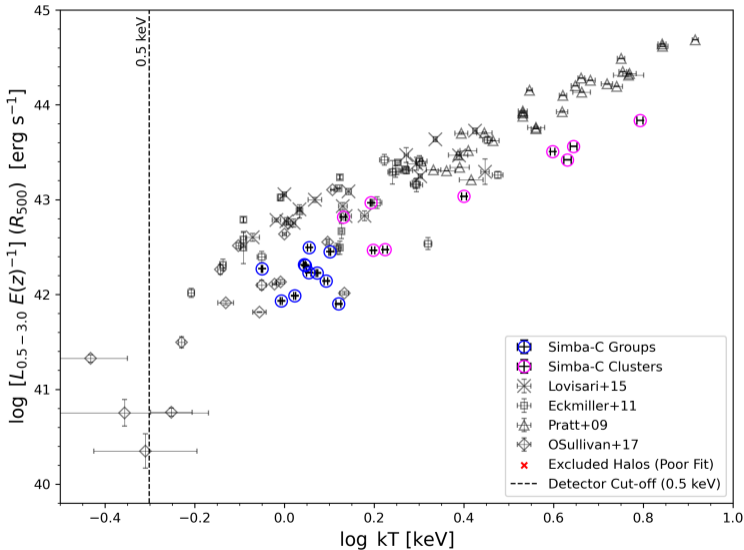




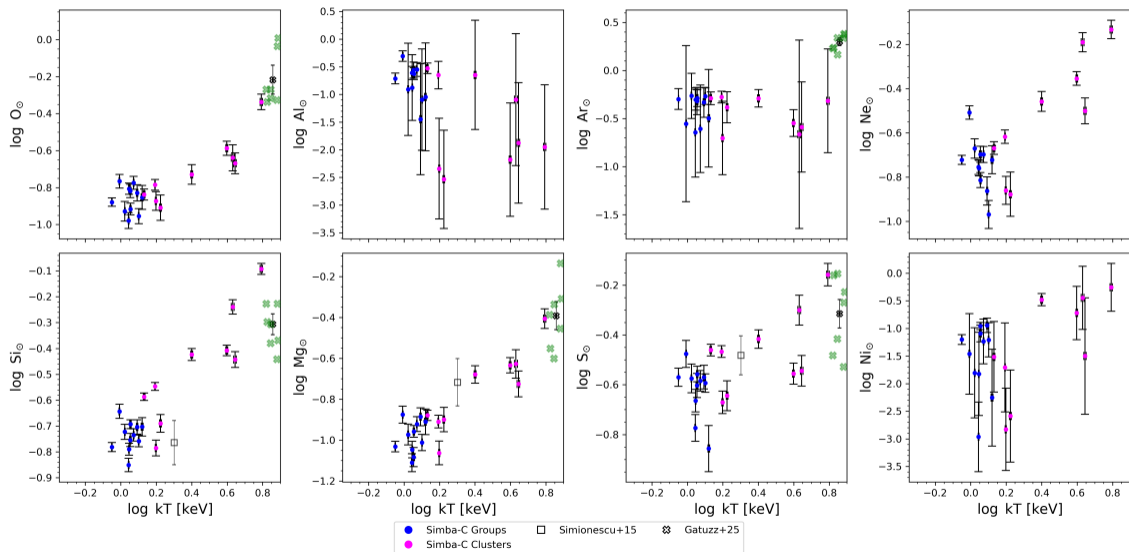
Preliminary project status: Halo selection



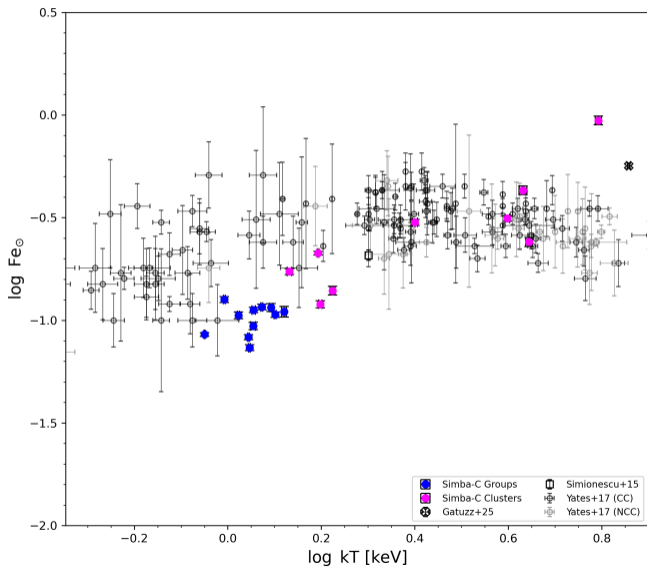
Preliminary project status: $L_x - T$ relation



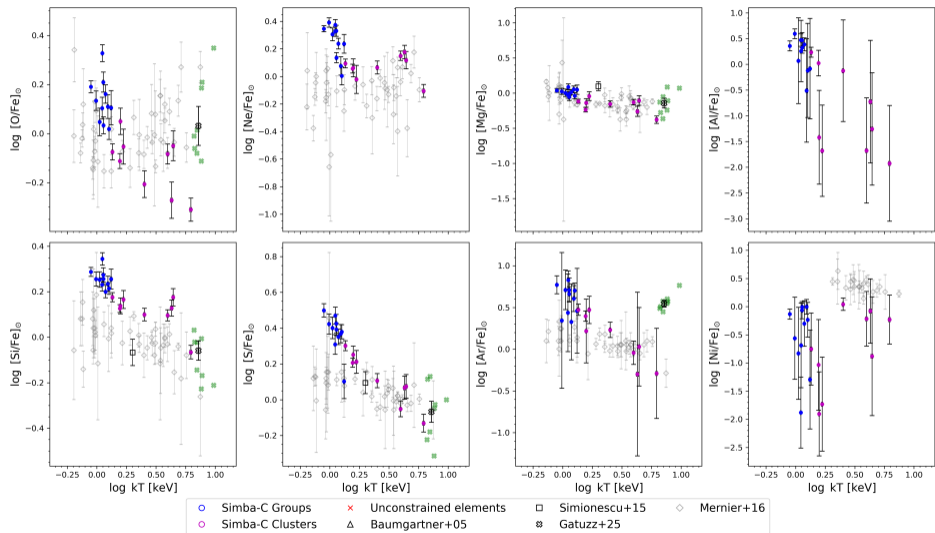
Preliminary project status: Elemental abundances



Preliminary project status: Fe abundances



Preliminary project status: Elemental abundances ratios



- Successfully update the mock X-ray *Athena X-IFU* observations for Simba-C.
 - Mosaic observations.
 - Data clean up.
 - Statistical XSPEC analysis setup.
- Started studying the mock X-ray abundance trends :)

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THANK YOU!!!



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SIMBA-C: an updated chemical enrichment model for galactic chemical evolution in the SIMBA simulation

Hough R. T., Rennehan D., Kobayashi C., Loubser S. I., Davé R., Babul A., Cui W., 2023, MNRAS, 525, 1061.

Simba-C: the evolution of the thermal and chemical properties in the intragroup medium

Hough R. T., Shao Z., Cui W., Loubser S. I., Babul A., Davé R., Rennehan D., Kobayashi C., 2024, MNRAS, 532, 476.

Updating MOXHA: Improving mock X-ray analysis for Simba-C and beyond

Hough R. T., Jennings F., Loubser S. I., Sonskamble S., In: *The Proceedings of SAIP2024, the 68th Annual Conference of the South African Institute of Physics*, 2020, pg. 420. ISBN:978-1-0370-2645-4.

Core to Cosmic Edge: Simba-C's New Take on Abundance Profiles in the Intragroup Medium at $z = 0$

Padawer-Blatt A., Shao Z., Hough R. T., Rennehan D., Barré R., Saeedzadeh V., Babul A., Davé R., Kobayashi C., Cui W., Mernier F., Gozaliasl G., 2025, Universe, 11, 47.

Mock X-ray spectral analysis of galaxy groups and clusters in Simba-C: elemental abundance trends

Hough R. T., Jennings F., Loubser S. I., Sonskamble S., Davé R., Babul A. (Planned submission 2026 - authors to be confirmed).