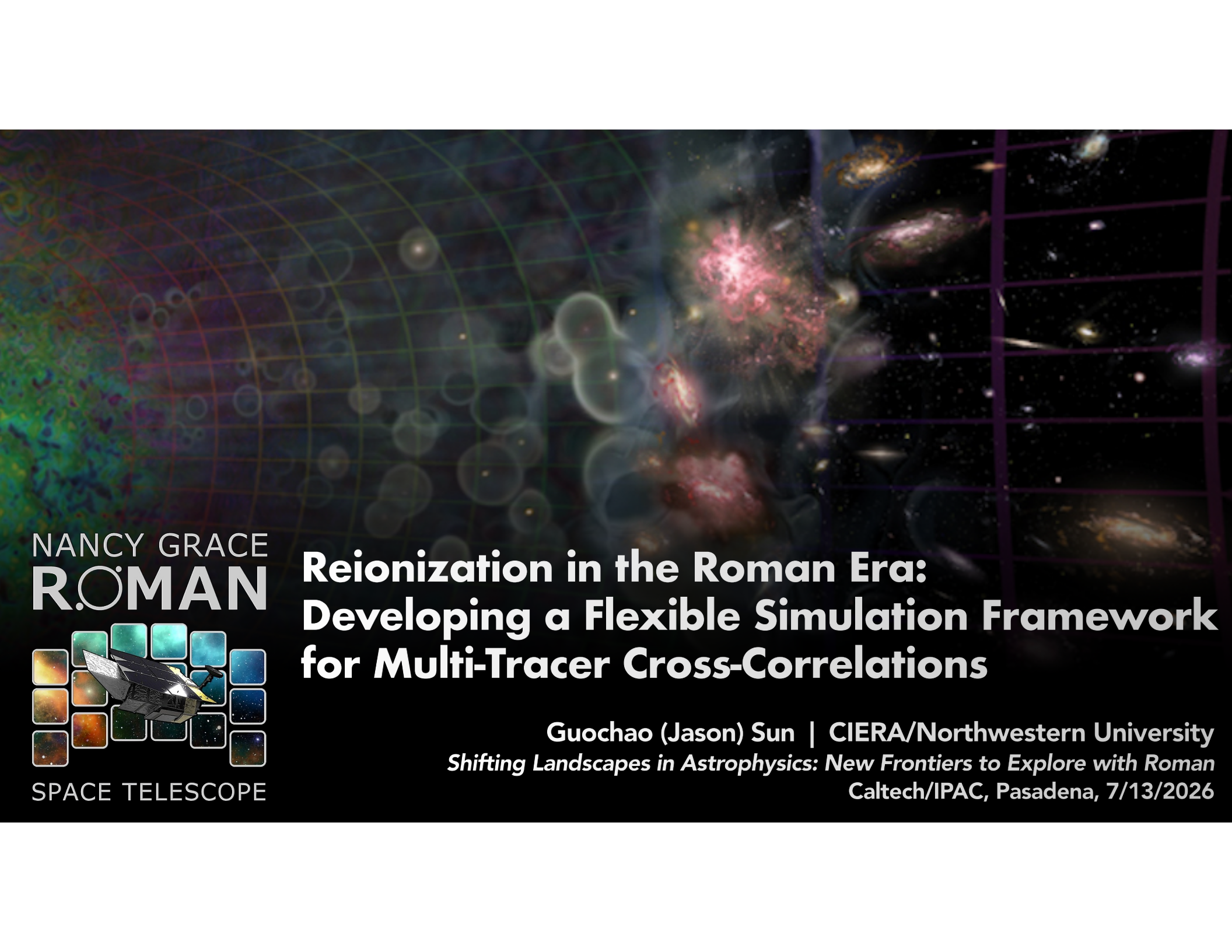




NANCY GRACE
R.OMAN



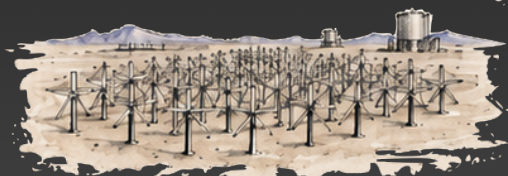
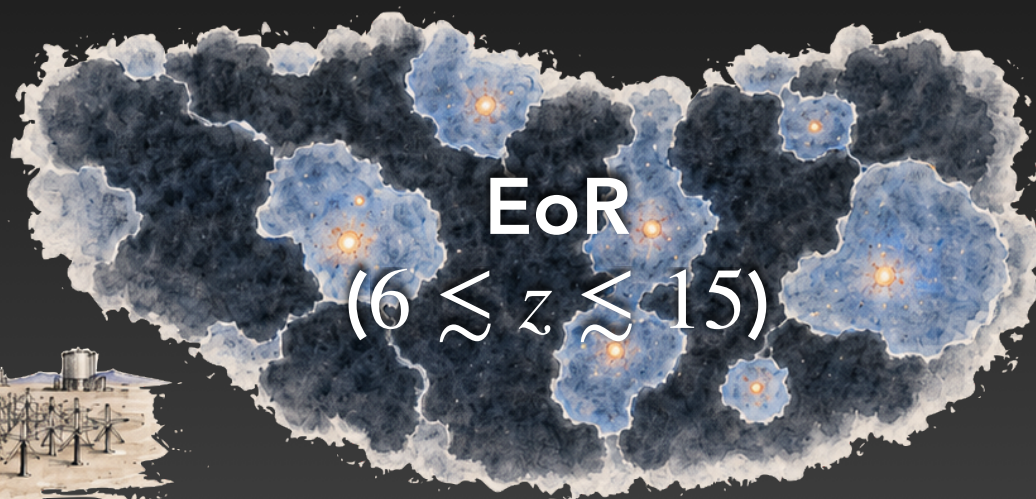
SPACE TELESCOPE

Reionization in the Roman Era: Developing a Flexible Simulation Framework for Multi-Tracer Cross-Correlations

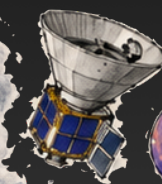
Guochao (Jason) Sun | CIERA/Northwestern University
Shifting Landscapes in Astrophysics: New Frontiers to Explore with Roman
Caltech/IPAC, Pasadena, 7/13/2026

Reionization science from cross-correlations with Roman

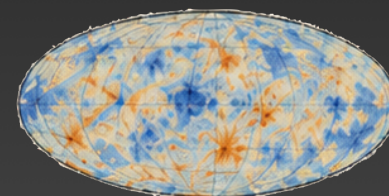
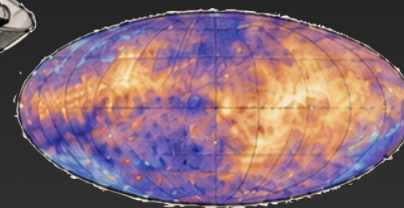
PI: A. Lidz Collaborators: [A. Kundu](#), [L.-J. Liu](#), [G. Sun](#), T.-C. Chang, J. Mirocha



HI 21cm (SKA-Low)

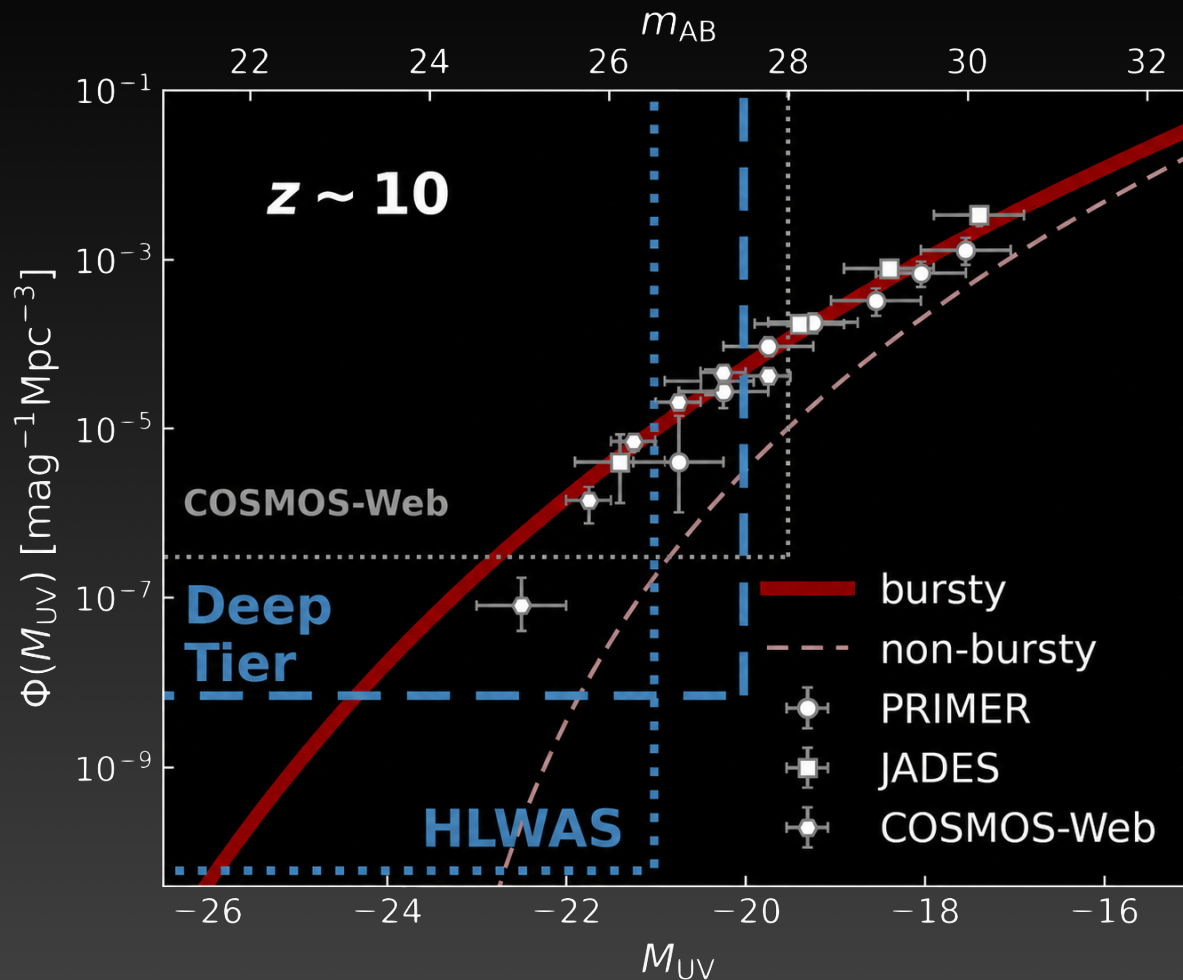


EBL (SPHEREx)



Patchy kSZ (SO)

Roman to revolutionize high-z galaxy surveys

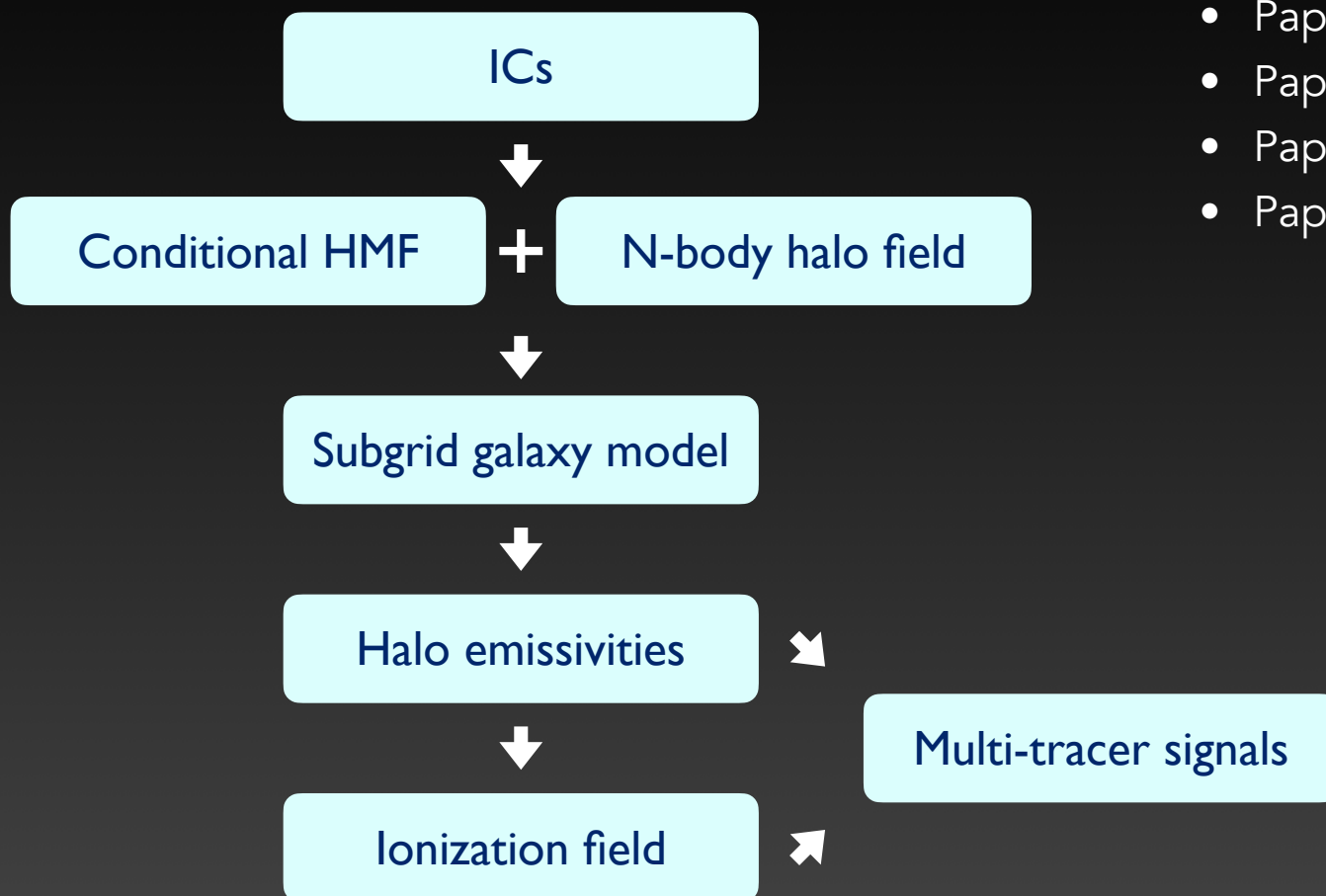


From talks by Steve and Simon...

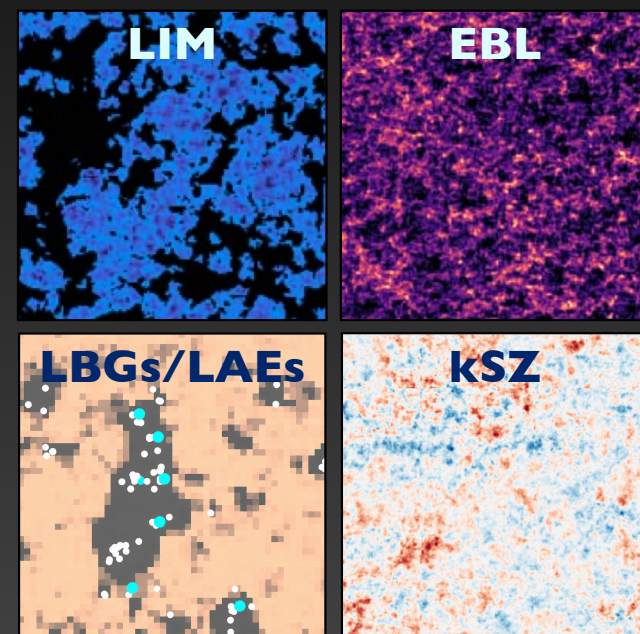
- A rich **statistical sample** of **bright galaxies** and their **environment** at Cosmic Dawn
- Significant boost of bright end by **bursty star formation**
- New lever arm on **galaxy physics** and access to **cross-correlations**

Simulating EoR cross-correlations with LIMFAST*

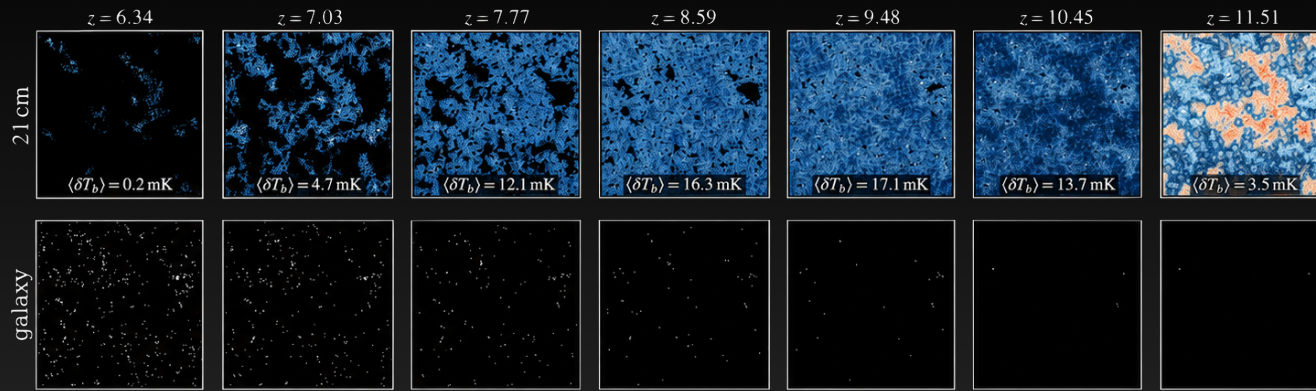
*An extension of the 21cmFAST code for high-z 21cm cosmology



- Paper I (2023): methodology
- Paper II (2023): EoR LIM applications
- Paper III (2025): EBL extension
- Paper IV (2026): SBI of galaxy physics
- Paper V (2026): Roman LBG x 21cm



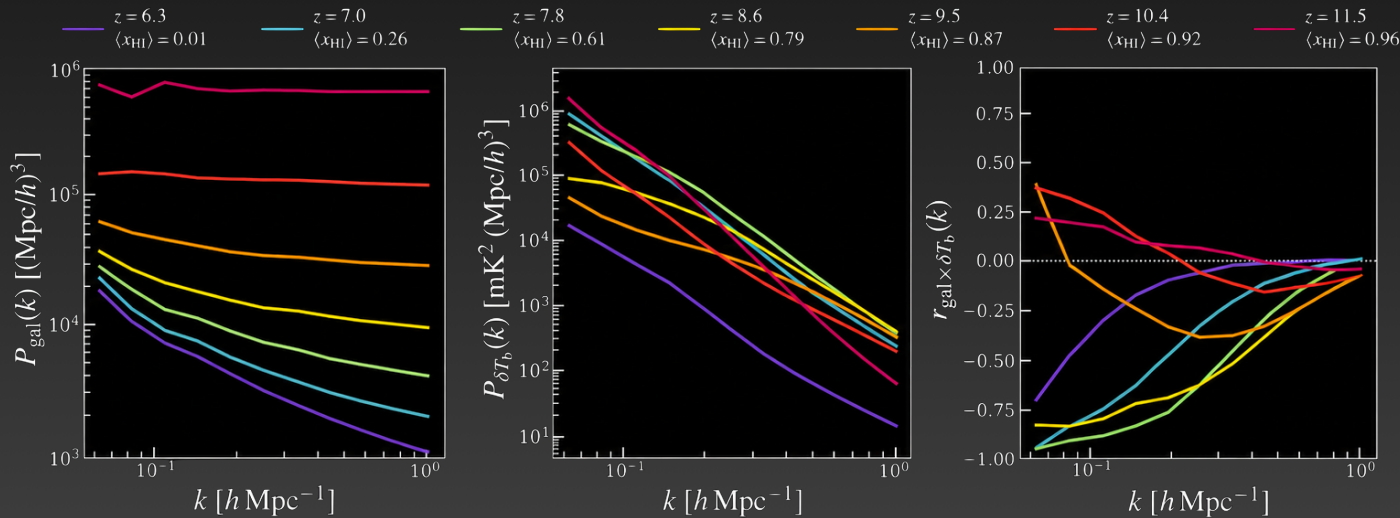
A pathway to map the EoR with galaxy x 21cm



- Ionizing source properties

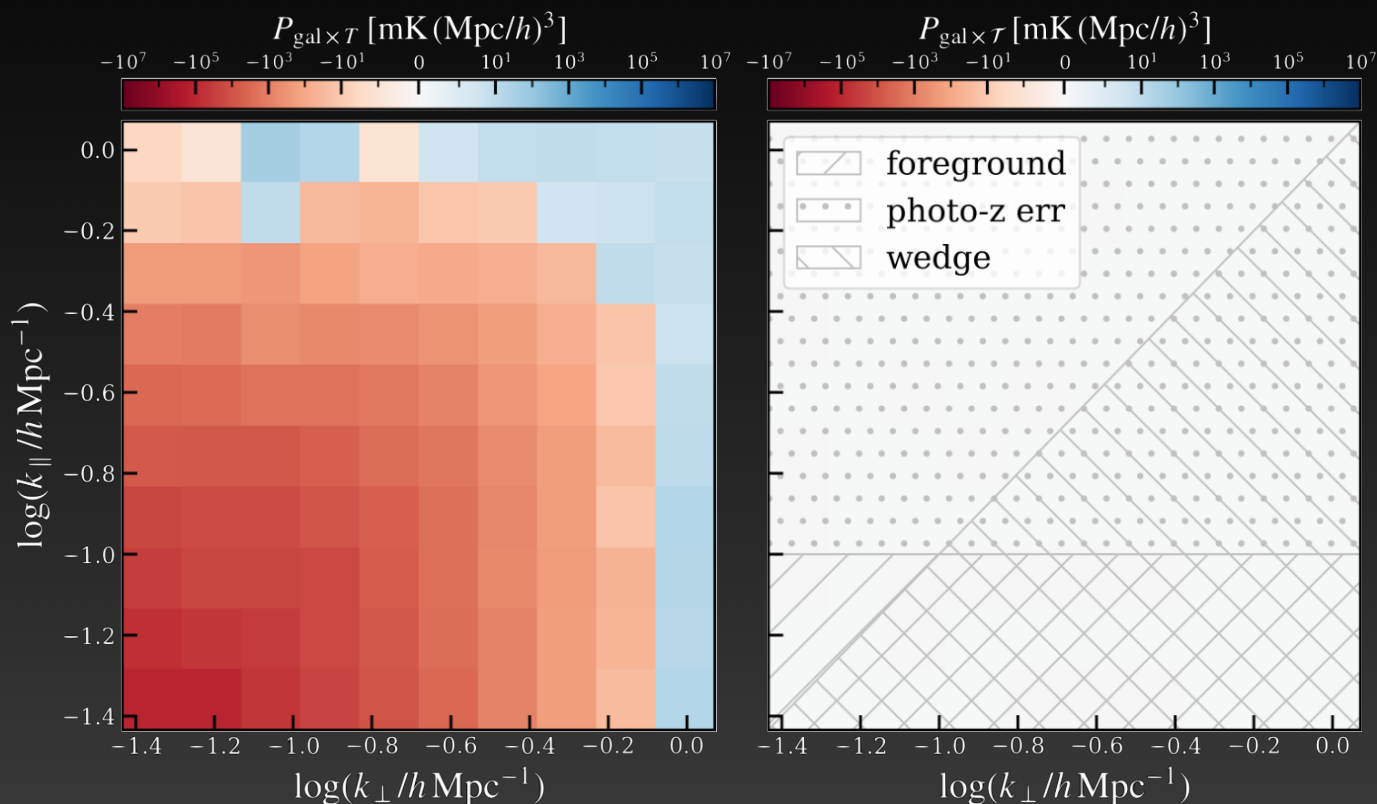
- Characteristic bubble sizes

- Stress test for 21cm IM



GS et al. (2026, in prep.)

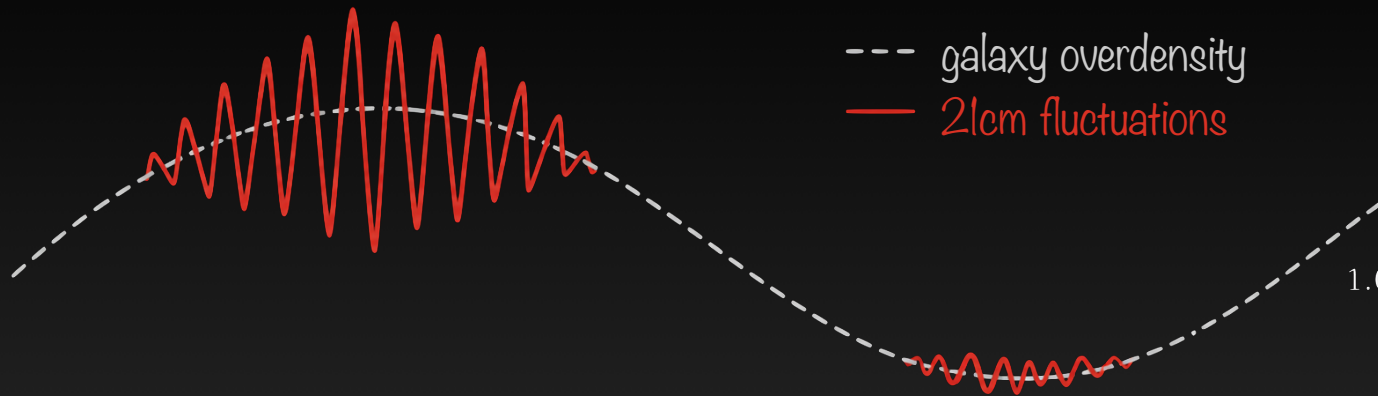
A practical challenge for LBG x 21cm (FG cleaned)



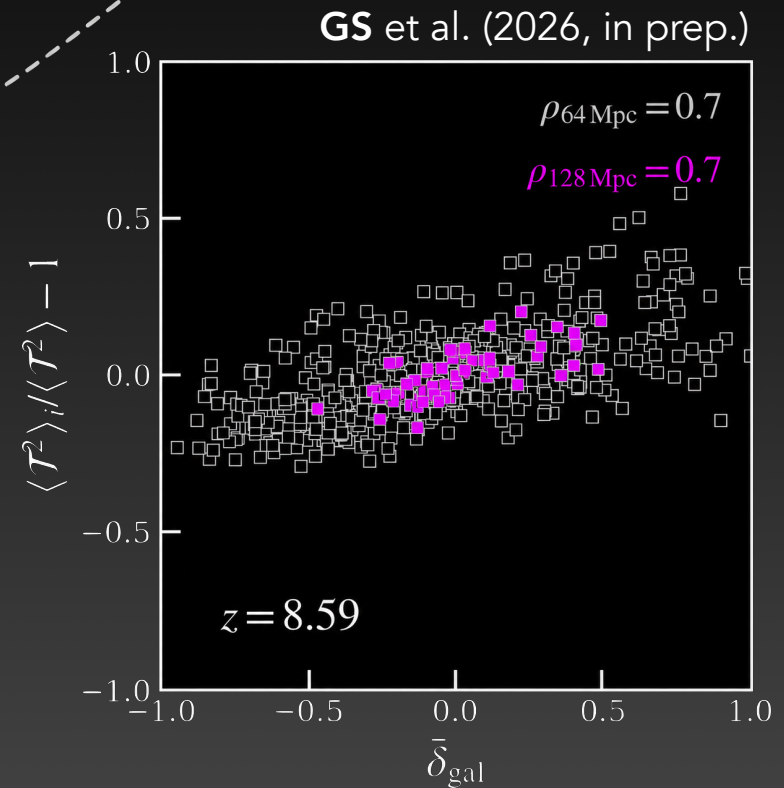
- **Poor photo-z accuracy** prohibits high $k_{\parallel}$ access
- **Smooth 21cm foreground** contaminates low $k_{\parallel}$
- **Unmatched Fourier-space coverage** makes direct LBG x 21cm signal vanish

GS et al. (2026, in prep.)

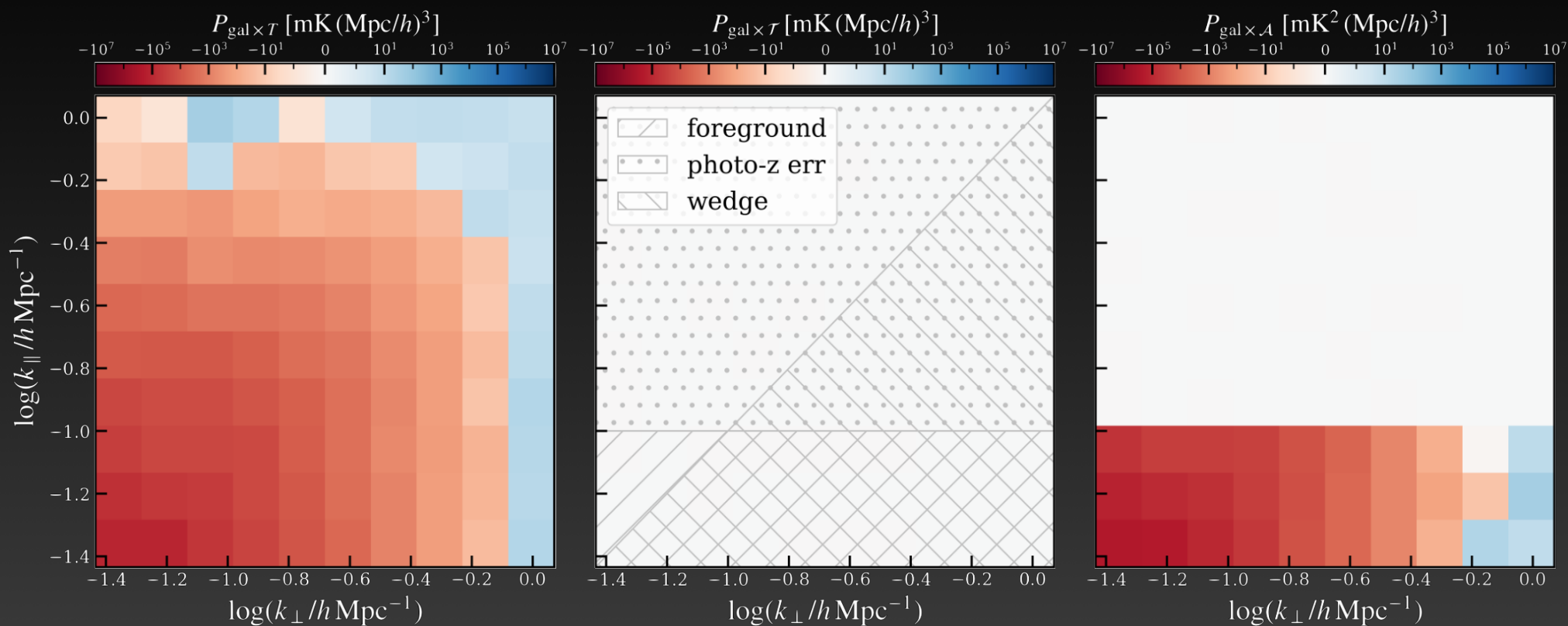
Higher-point correlation as a promising solution



- **Small-scale (high $k_{\parallel}$)** 21cm fluctuations modulated by **large-scale (low $k_{\parallel}$)** galaxy overdensities
- Visible from correlation between **localized 21cm variance** and **galaxy environment** in sub-volumes

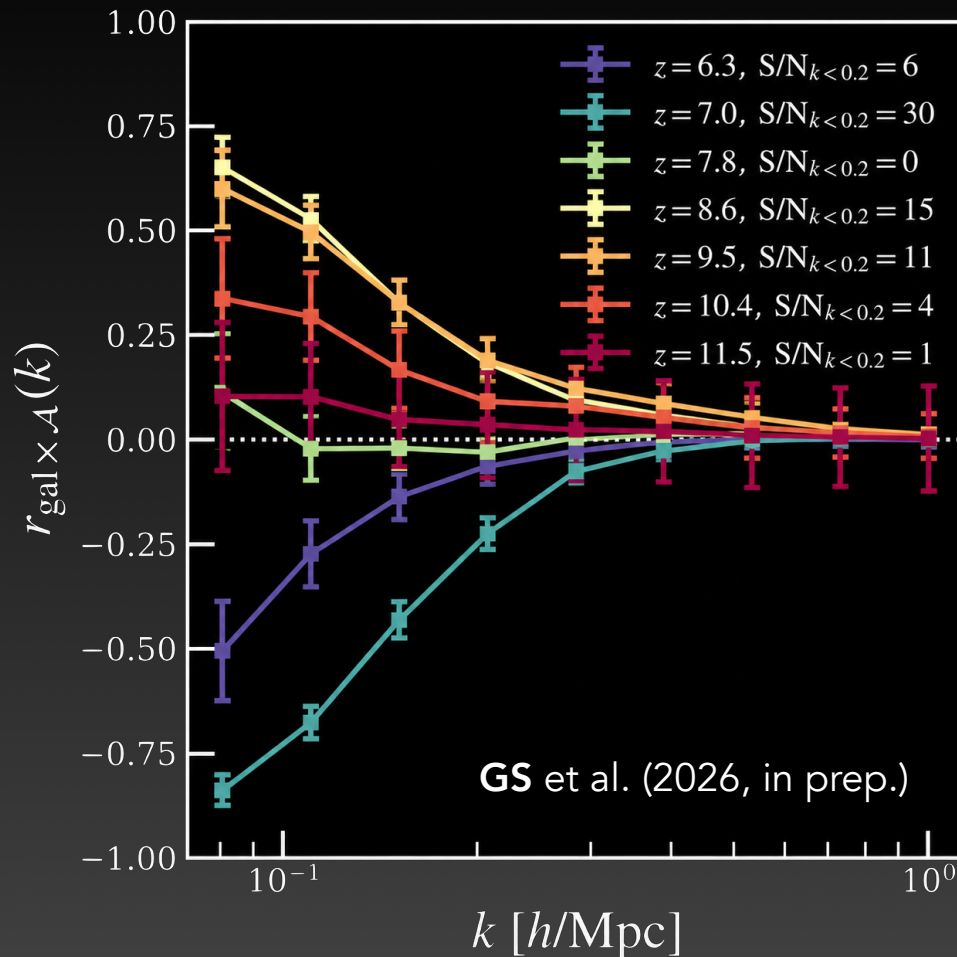


Non-vanishing LBG x 21cm² signal probes the EoR



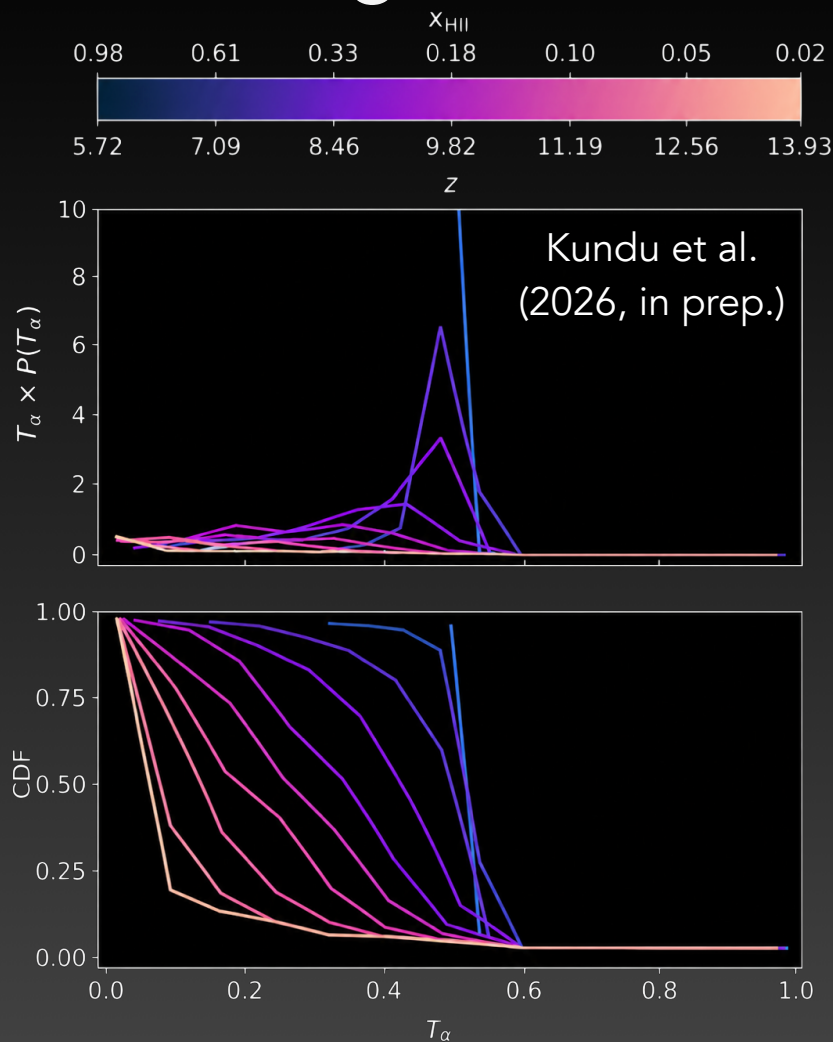
GS et al. (2026, in prep.)

A smoking-gun sign flip for LBG x 21cm²



- A characteristic **positive-to-negative transition (i.e., sign flip)** readily detectable by Roman + SKA-Low
- Primarily driven by how **neutral fraction fluctuations** response to galaxy overdensities
- Constraints on **reionization** and **galaxy formation** physics

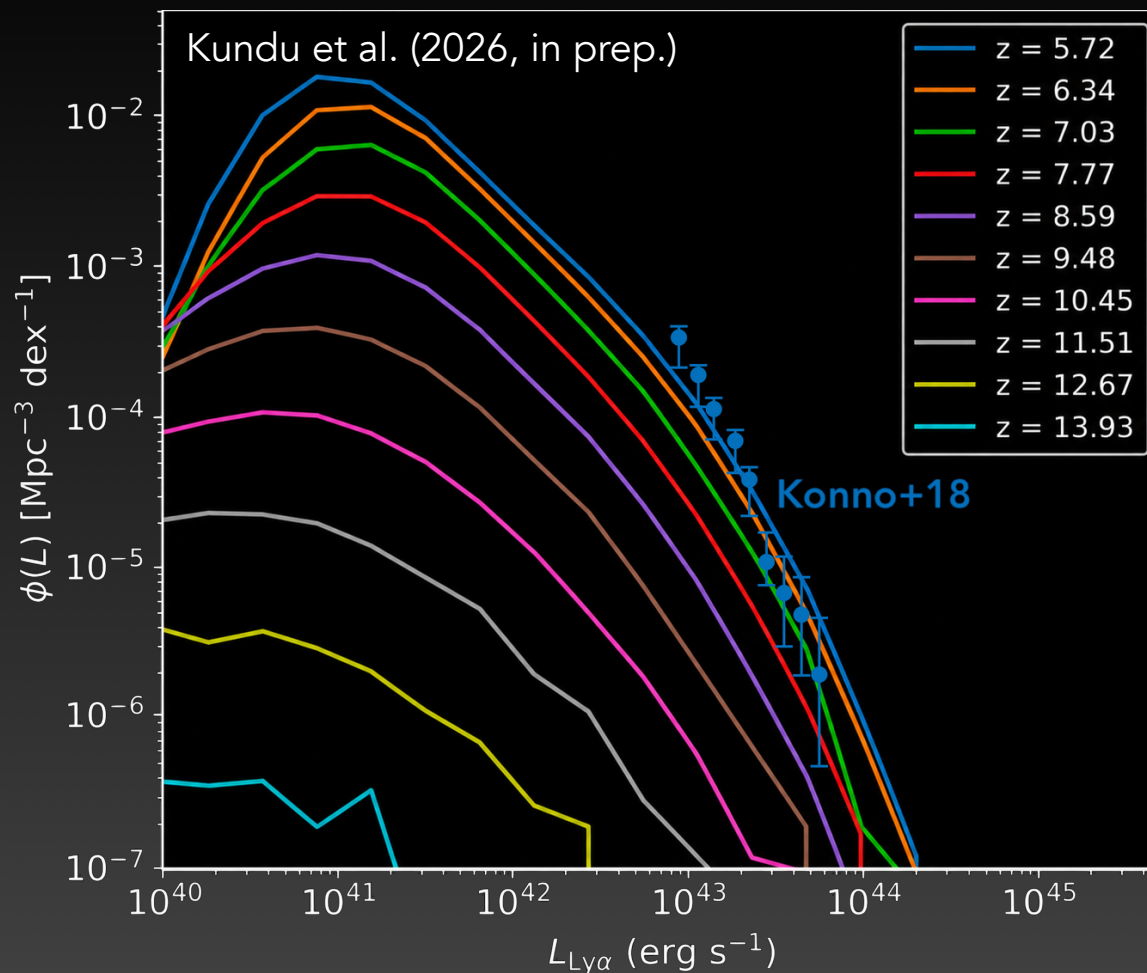
Modeling Roman LAEs — fewer but more powerful



By similar motivations Michael discussed...

- **Semi-analytic model** for Ly α damping wing absorption given **LIMFAST** ionization field and assumed **intrinsic line profile**
- **Growth of Ly α transmission distribution** with decreasing redshift and global neutral fraction

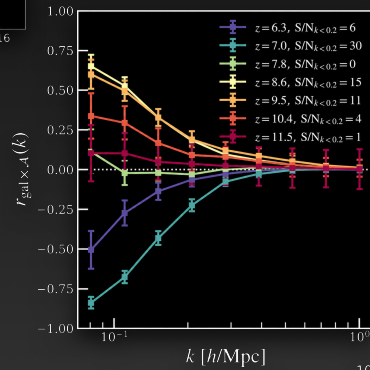
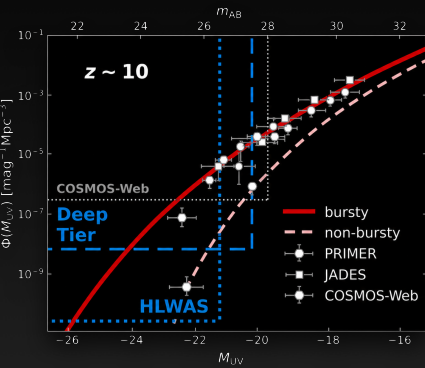
Probing reionization with LAE statistics



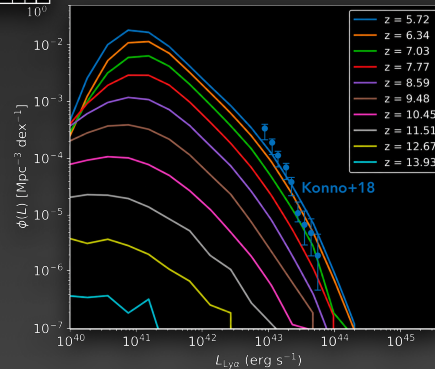
- Anchor to **observed Ly α EW distribution** at $z \sim 6$
- Self-consistently predicting **LAE luminosity function and clustering** with IGM transmission in LIMFAST
- Exploring **cross-correlation opportunities** with multiple LIM signals (e.g., 21cm, [CII], CO)

Summary

- Roman will soon redefine census of bright galaxies at Cosmic Dawn



- LBG x 21cm² — through its characteristic sign flip — will be a promising probe for EoR



- LAEs will be truly informative by themselves & in cross-correlations

Backup slides

