



How to start mapping the CGM in emission without waiting 20 years

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University of Arizona

Cosmic Origins Program Analysis Group (COPAG) Session
Sunday, January 7th, 2024
AAS Meeting, New Orleans

NASA UV missions in development:

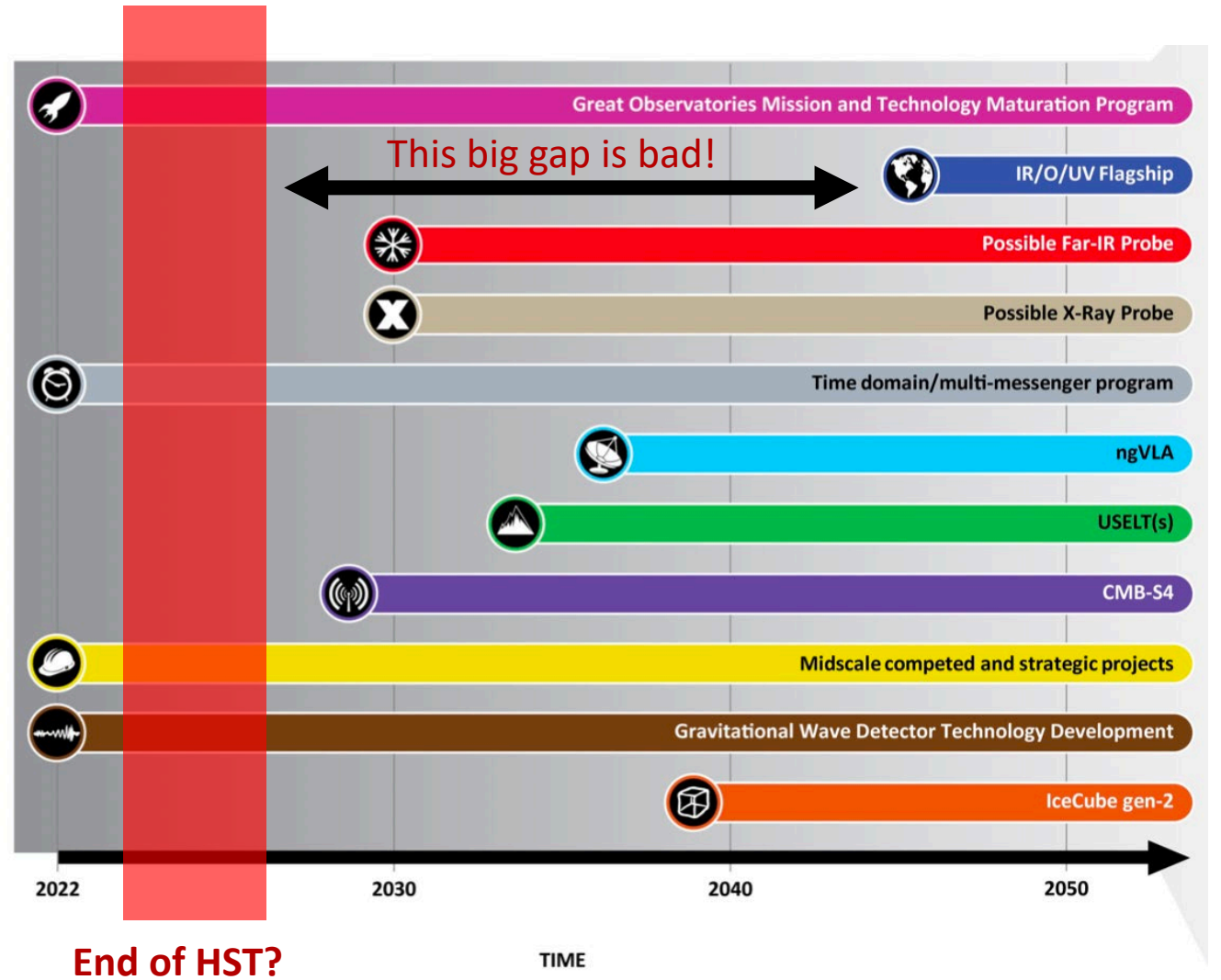
Currently Funded:

- SPARCs- CubeSat, Imager, focused on stellar variability. PI: Evgenia Shkolnik
- CUTE- CubeSat, Imager, focused on stellar variability. PI: Kevin France
- SPRITE- CubeSat, spectrograph, emission from galaxies. PI: Brian Fleming
- Aspera- CubeSat, spectrograph, emission from nearby galaxy CGM. PI: Carlos Vargas
- A small range of sub-orbital missions (FIREBall, SISTENE, etc)

In various stages of pre-phase B development:

- UVEX- One of two MIDEX missions. Imager, Transient focused. PI: Fiona Harrison
- Habitable Worlds Observatory 🧐

More
(ANY!) UV
missions in
the next 20
years are
critical





Douglas



Behroozi



Chung, PS



Zaritsky



Kim



Hamden, DPI



Vargas, PI



Corlies



Schiminovich



Hoadley

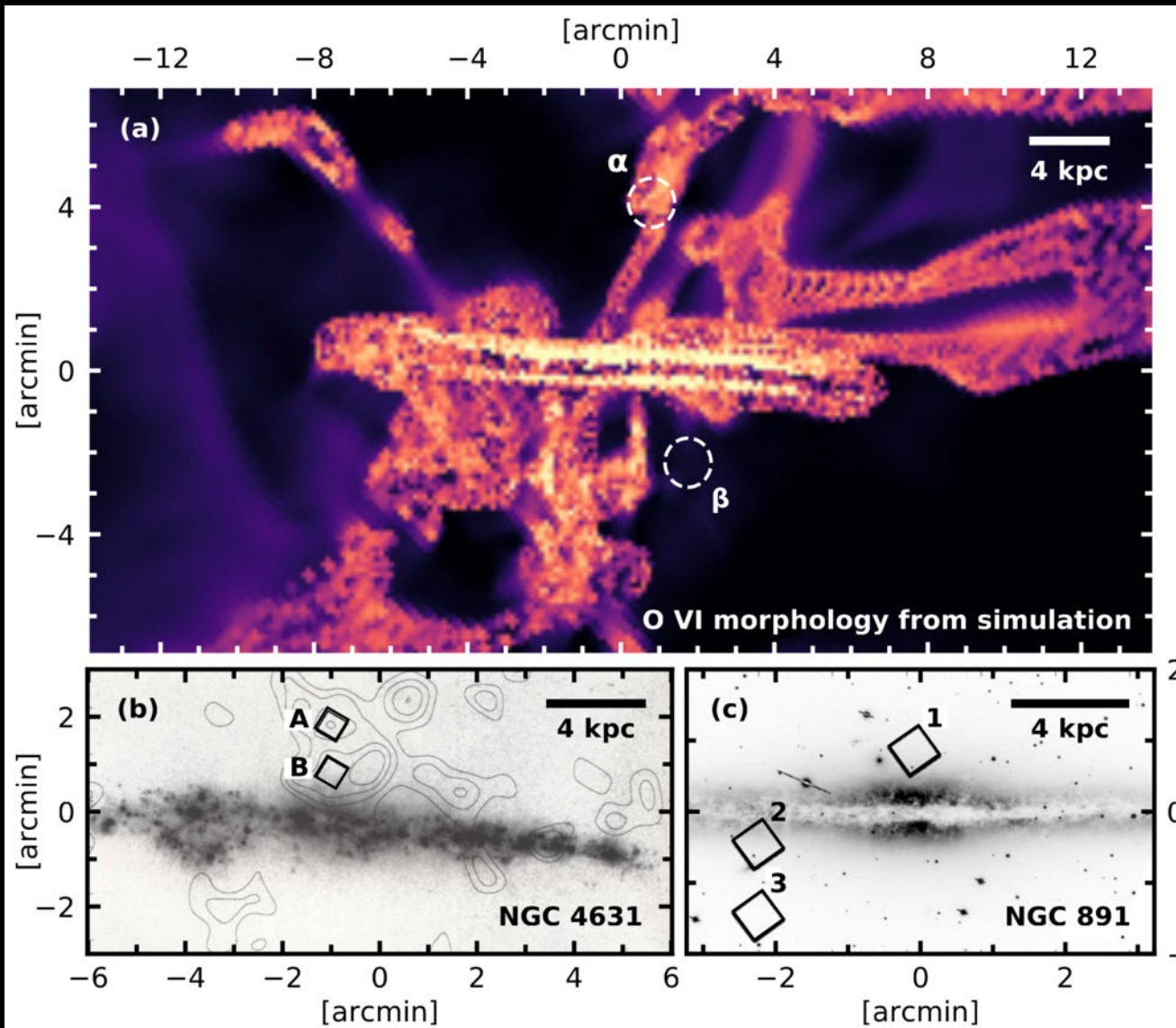
ASPERA

REVEALING THE DIFFUSE UNIVERSE

Not shown:

- Tom McMahon (Mission Manager)
- Kerry Gonzales (Systems Engineer)
- R.-J. Dettmar (Ruhr University)
- Aafaque Khan (UA, Grad Student)
- Simran Agarwal (UA, Grad Student)
- Jessica Li (UA, Grad Student)

NASA Astrophysics SmallSat Studies (AS3) proposal submitted December 2019. Not selected, re-formulated for 2020 Pioneers. Selected in January 2021, now in Phase B



Otte et al. (2003) + Corlies (private comm) + Haeun Chung

Observing the CGM in nearby galaxies!

- Strongest line – O VI @ $\lambda\lambda$ 1032, 1038 Å, rest-frame
- Surface brightness $< 1 \times 10^{-18}$ erg s⁻¹ cm⁻² arcsec⁻² (near z=0)
- Very limited existing observations

Anticipated Launch in 2025

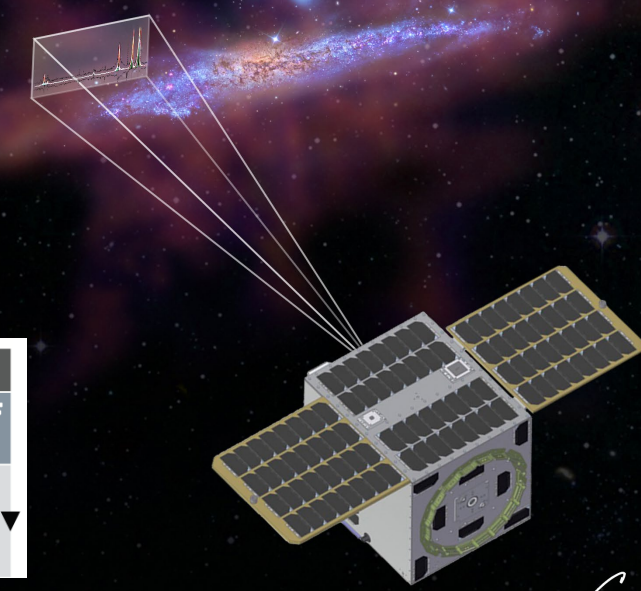
9 months of operations

All of my graduate student researchers are involved in critical components! Several opportunities for undergraduate work as well!

CY 2021		CY 2022		CY 2023		CY 2024		CY 2025		26
PHASE A 5 mo.	BRIDGE 4 mo.	PHASE B: Formulation / 13 mo.		PHASE C&D: Implementation 28 months				PHASE E 9 mo.		F 1
▼ PROJECT START 4/1		▼ PDR 6/27				PSR 2/13 ▼		▼ PLAR 6/20		
CDSR 9/1 ▼	▼ ATP 1/7		▼ CDR 1/25	SC PAYLOAD ATLO 10/3 ▼	LAUNCH ★ 5/22			EOM 3/31 ▼		
SRR 10/12 ▼	▼ KDP-B 1/7		▼ KDP-C 2/1	SIR 9/30 ▼	KDP-E 5/22 ▼			KDP-F 2/23 ▼		

We are here

ASPERA
REVEALING THE DIFFUSE UNIVERSE



Carlos J. Vargas
Carlos J. Vargas

RUHR
UNIVERSITÄT
BOCHUM

Sensor
Sciences

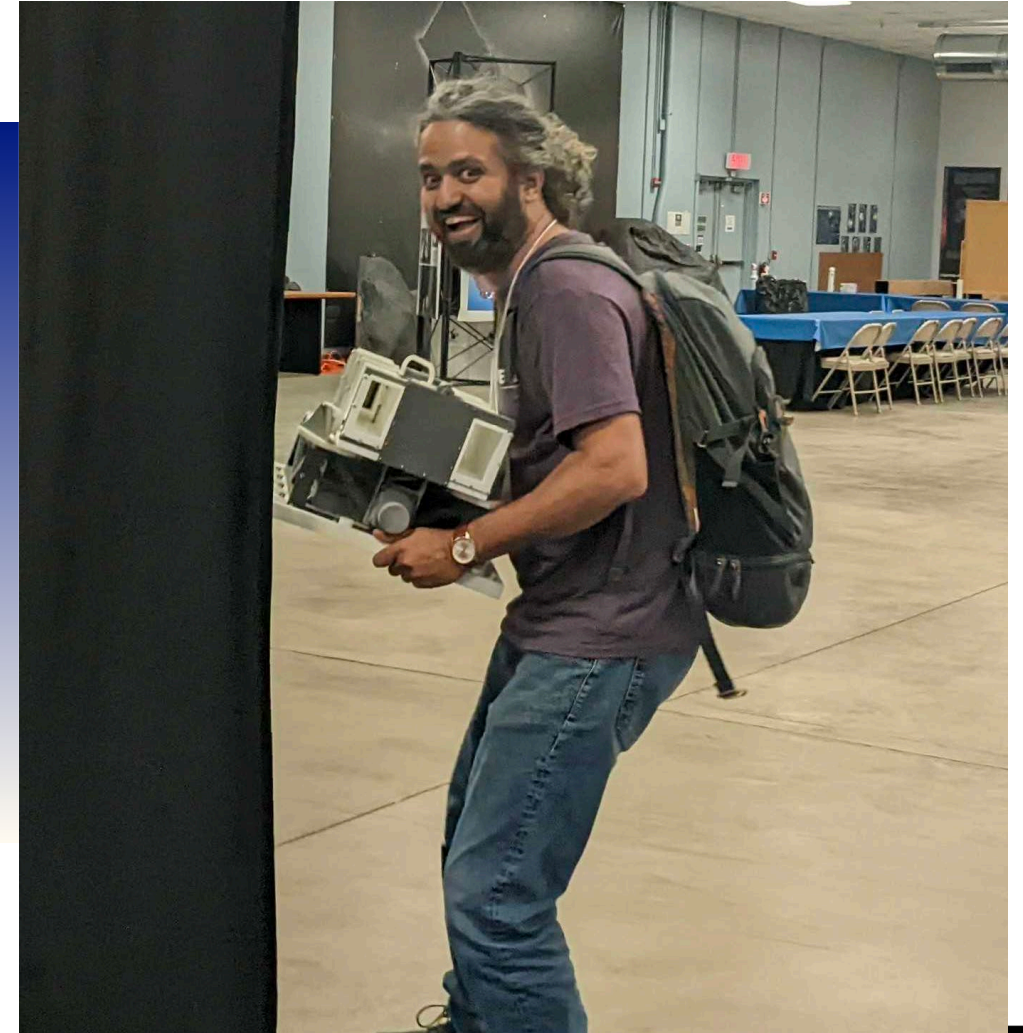
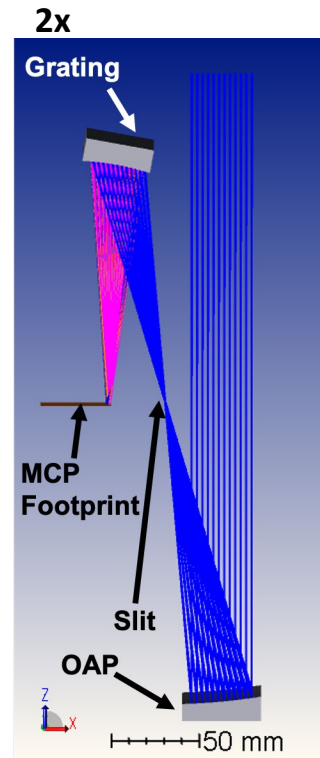
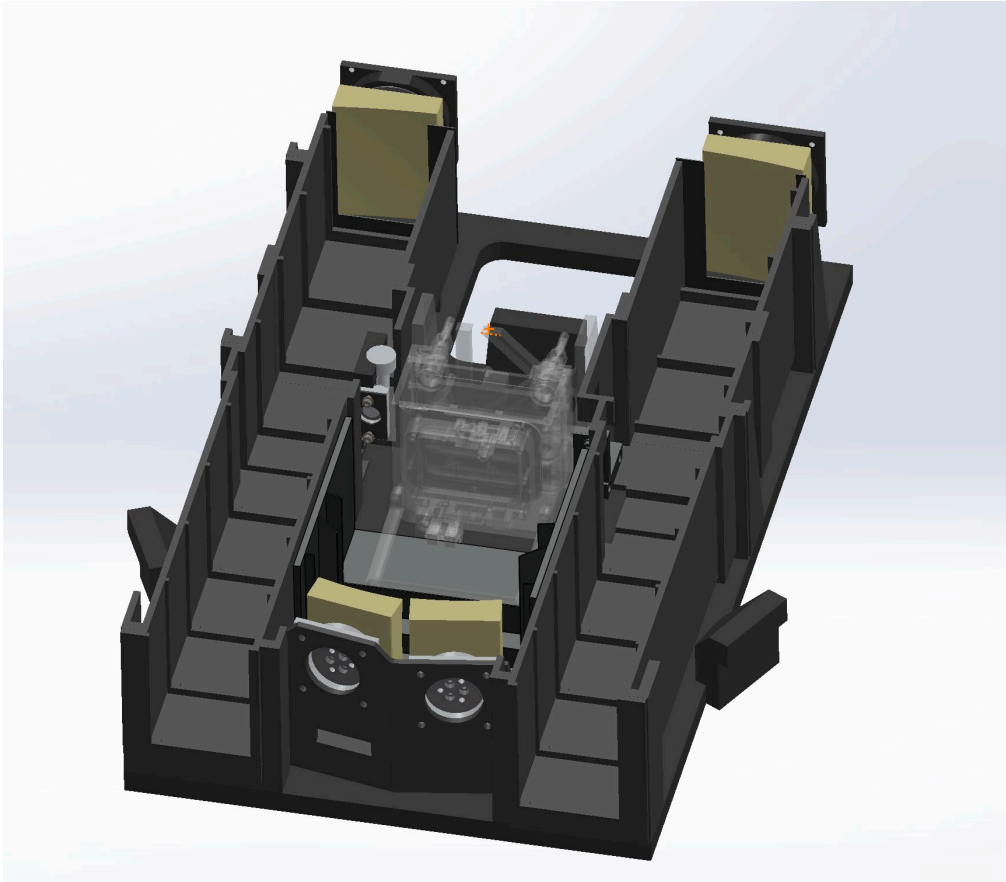
ASCENDING
NODE
IOWA

THE UNIVERSITY
OF ARIZONA

COLUMBIA
UNIVERSITY

UTIAS
SFL

- EFFICIENT AND HIGH HERITAGE



See Chung et al. (2021; SPIE) for more



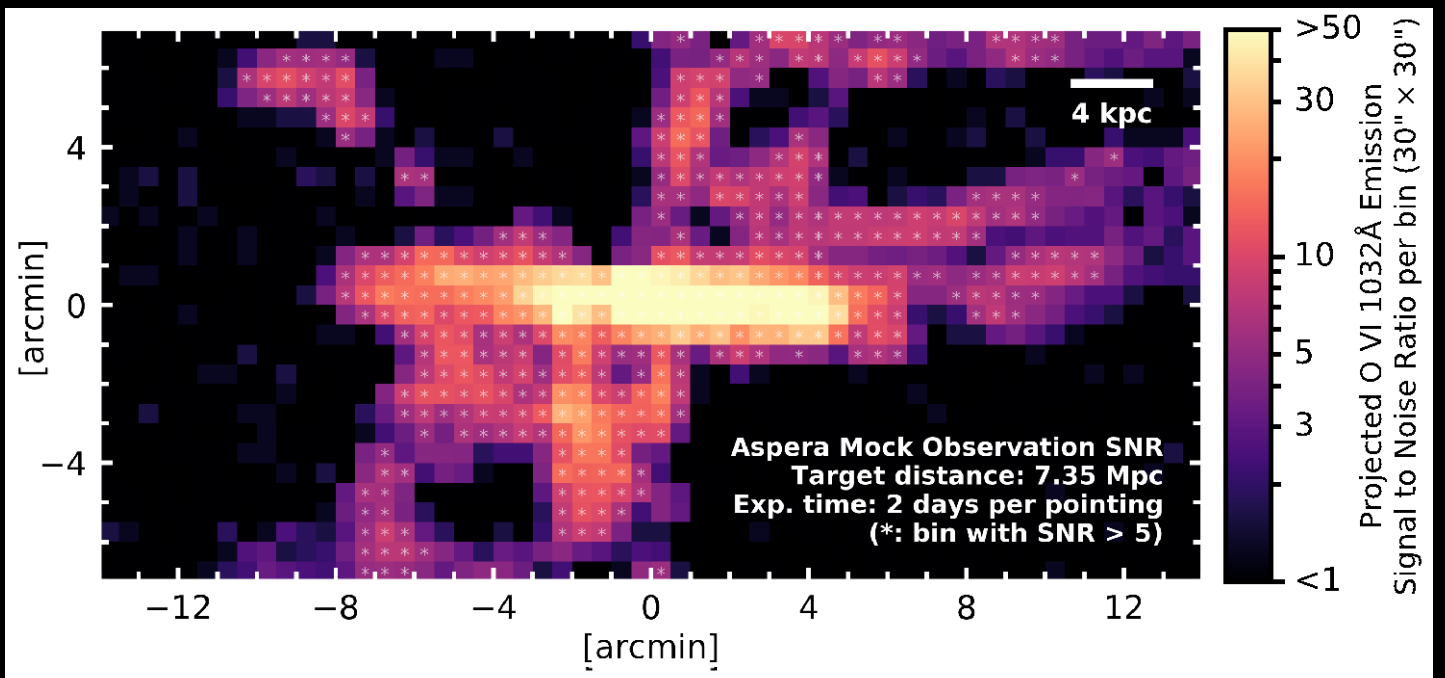
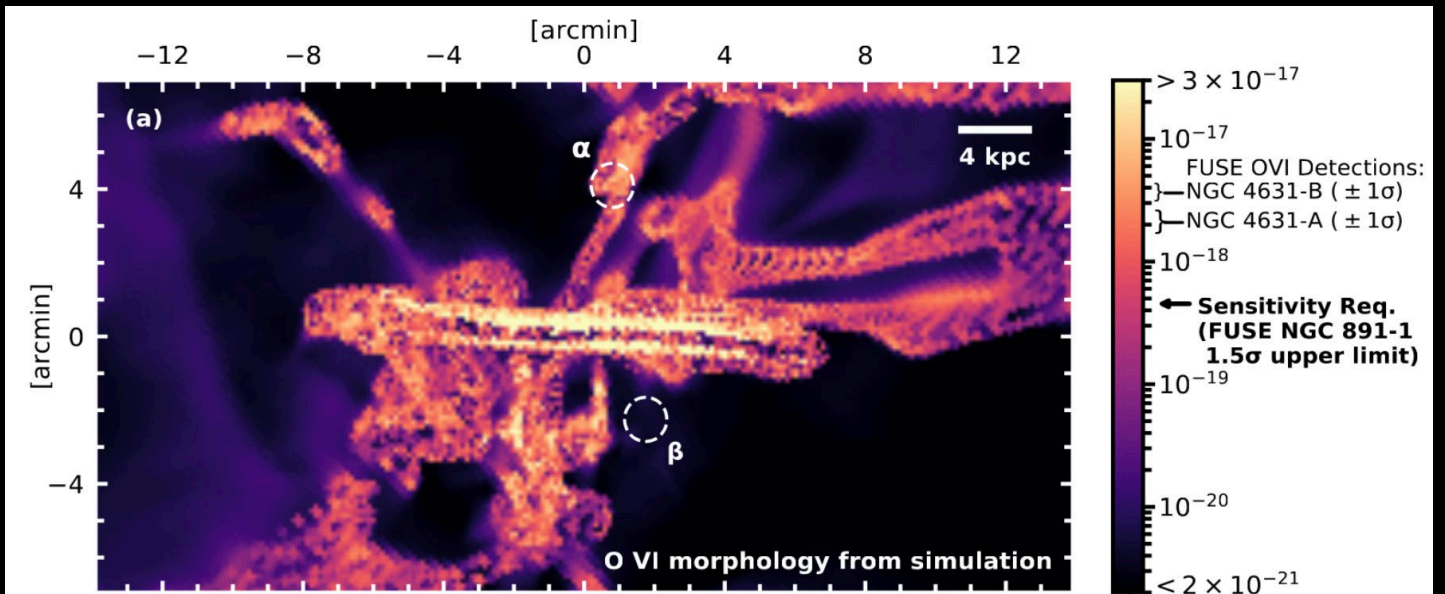
IOWA



RUB



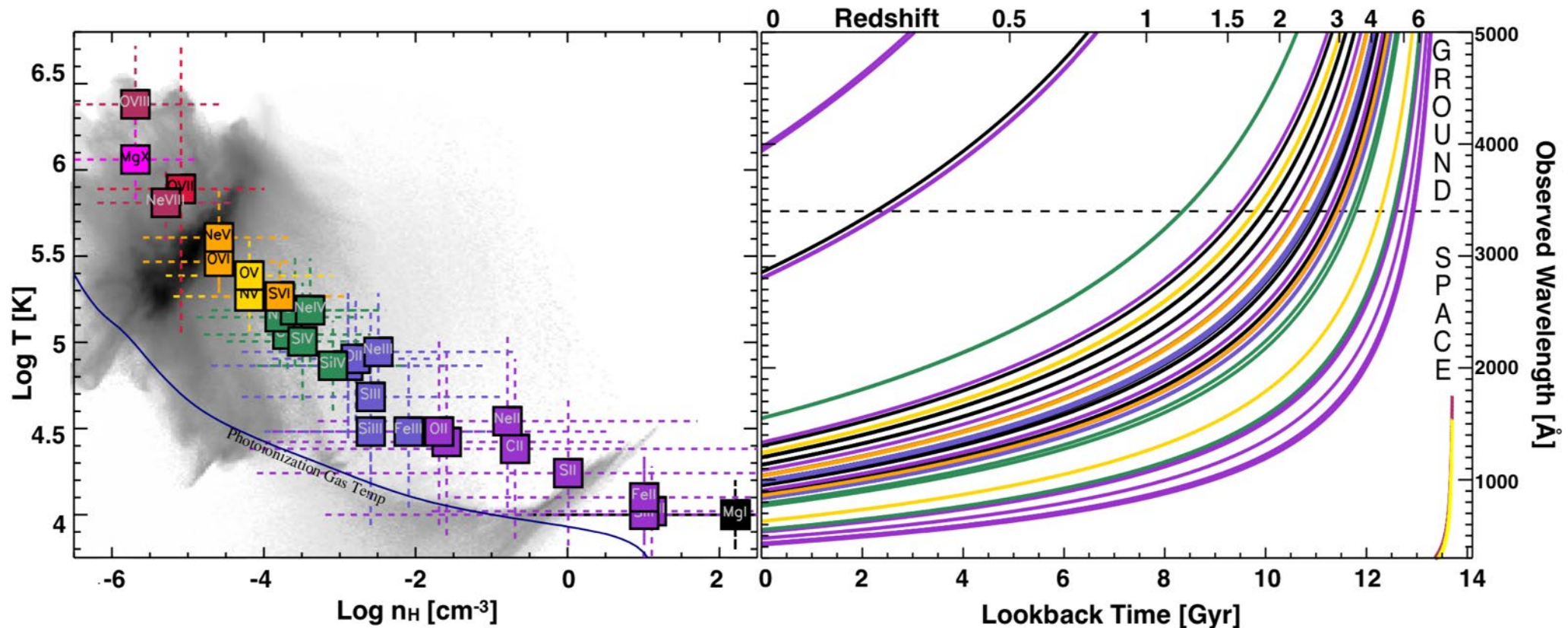
Aspera Mock Observation



- Includes system response, spacecraft pointing/jitter, and aberration
- Asterisks \rightarrow SNR > 5
- Exposure time \rightarrow 2 days per pointing
14 days total

There are many other emission lines to target

- Dominant species in CGM/IGM Observations, Figure from Tumlinson, 2019 (Astro2020 White Paper)
- Most CGM lines are in the Space UV, EUV, and Soft X-ray

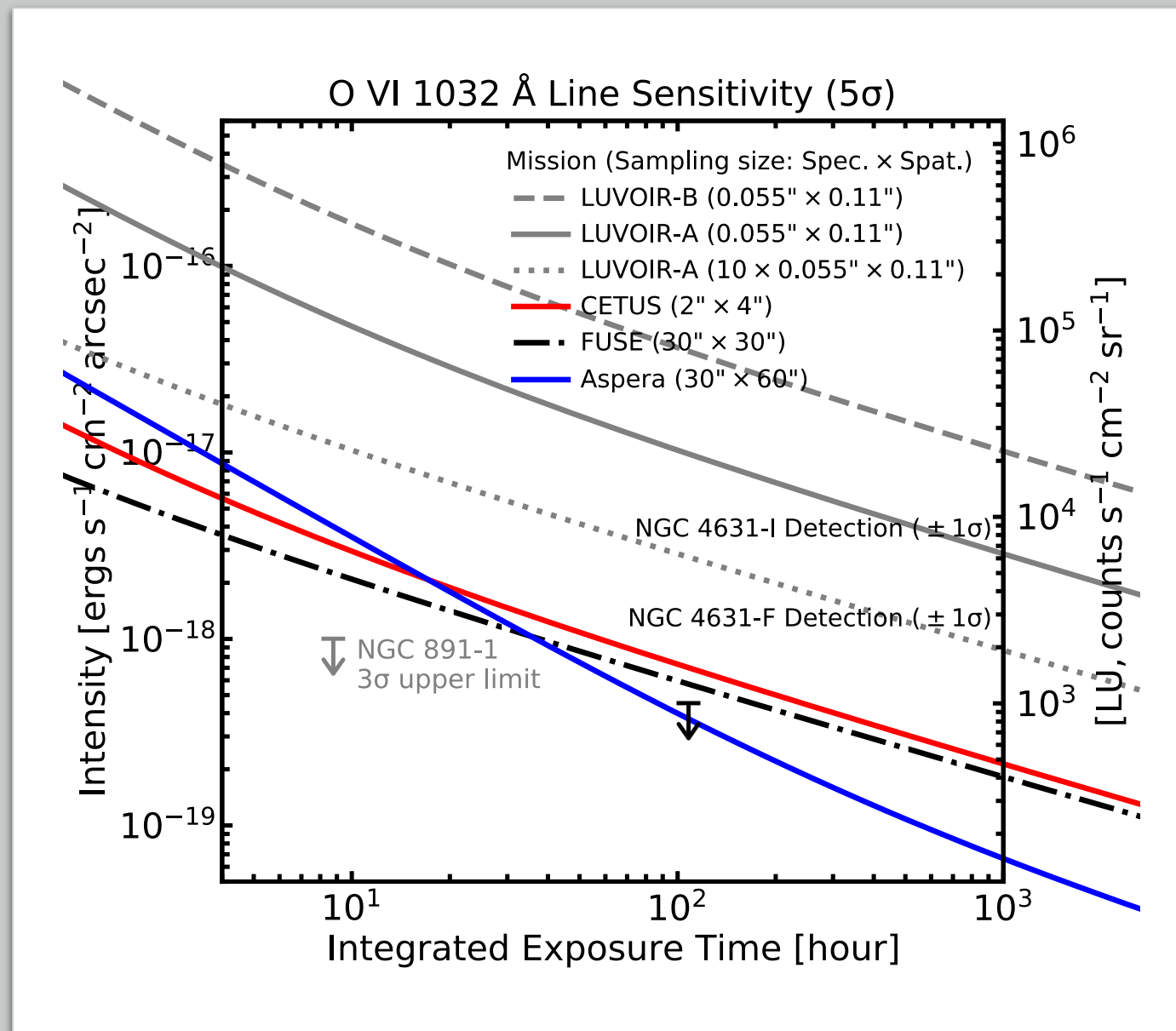


How well can future missions do?

Figure shows performance for a small sample of missions for a particular CGM line

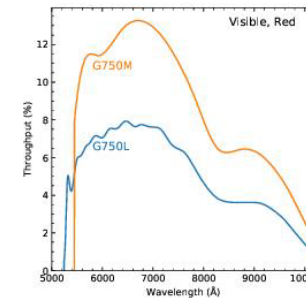
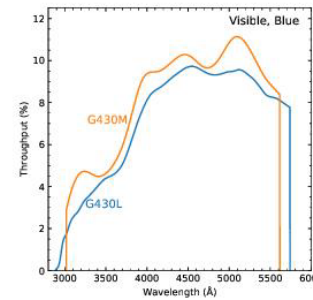
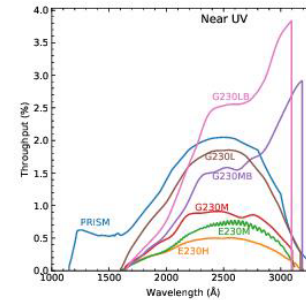
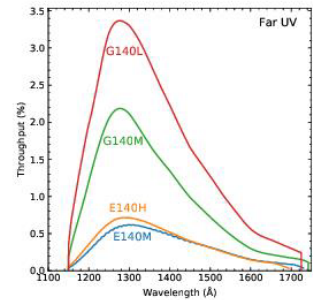
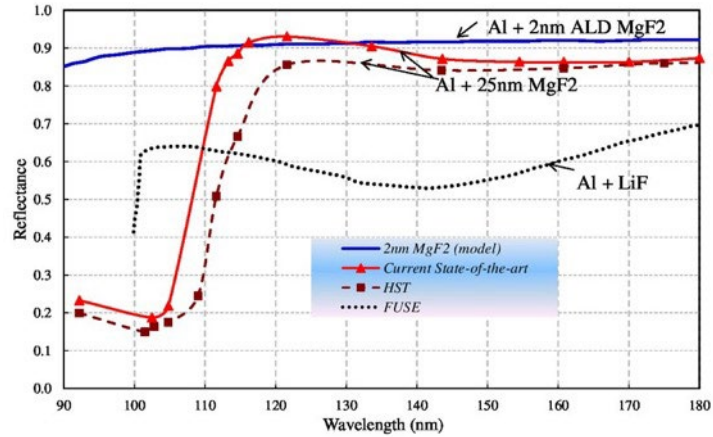
Assumptions that future flagships will solve all problems are maybe wrong due to balance between large aperture and very small resolution elements.

Power of dedicated SmallSats: Aspera is equivalent to Explorer/Probe Class missions (again, resolution element size is key here)



Why Now?

Technology & easy access to space!



I'm happy to talk at length anytime about UV detectors!

So, what's the ask here?



- Highly specialized UV telescopes can be built now for small budgets (MoOs, Pioneers, Explorers, Sub-orbital)
- Small payloads can do the science of last decade's explorers IF your parameters are set correctly
 - For the CGM
 - Nearby Galaxies
 - Large FOV, Large resolution elements
 - Time!
- Consider who traditionally becomes a PI vs. who CAN be a great PI!

A call to action

- Next Opportunities:
 - APRA (Every Year, \$10M and smaller sub-orbital investigations)
 - Pioneers (Next opportunity in 2025, typically every year, \$20M)
 - SMEX (Due mid-2025, full SMEX ~\$150M and Missions of Opportunity, \$40M)
- If this seems interesting to you and you don't know where to start- ask me!
- **DON'T wait for HWO to launch to answer your UV related, CGM related, or space related science questions!**