Kinematic Weak Lensing and You

Eric Huff

JPL

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My adventures in shear calibration over the decades

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Kinematic Weak Lensing

and also

The Low-Redshift CGM in Emission

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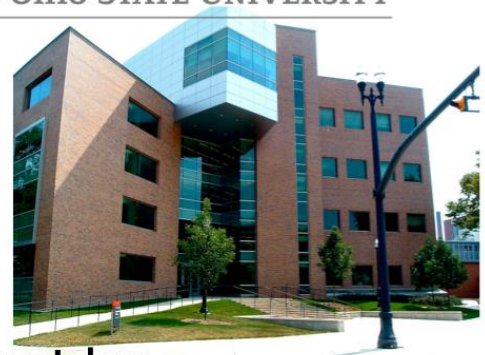
How I got here, and where I went after.

THE OHIO STATE UNIVERSITY



postdoc

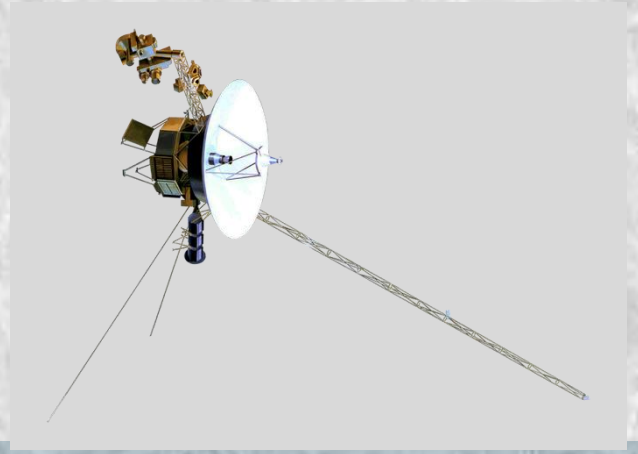
PhD

grew up

college

JPL

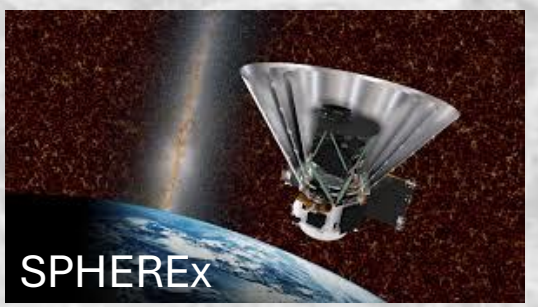

167
CONFERENCE ROOM
230
SPACE FLIGHT
OPERATIONS FACILITY



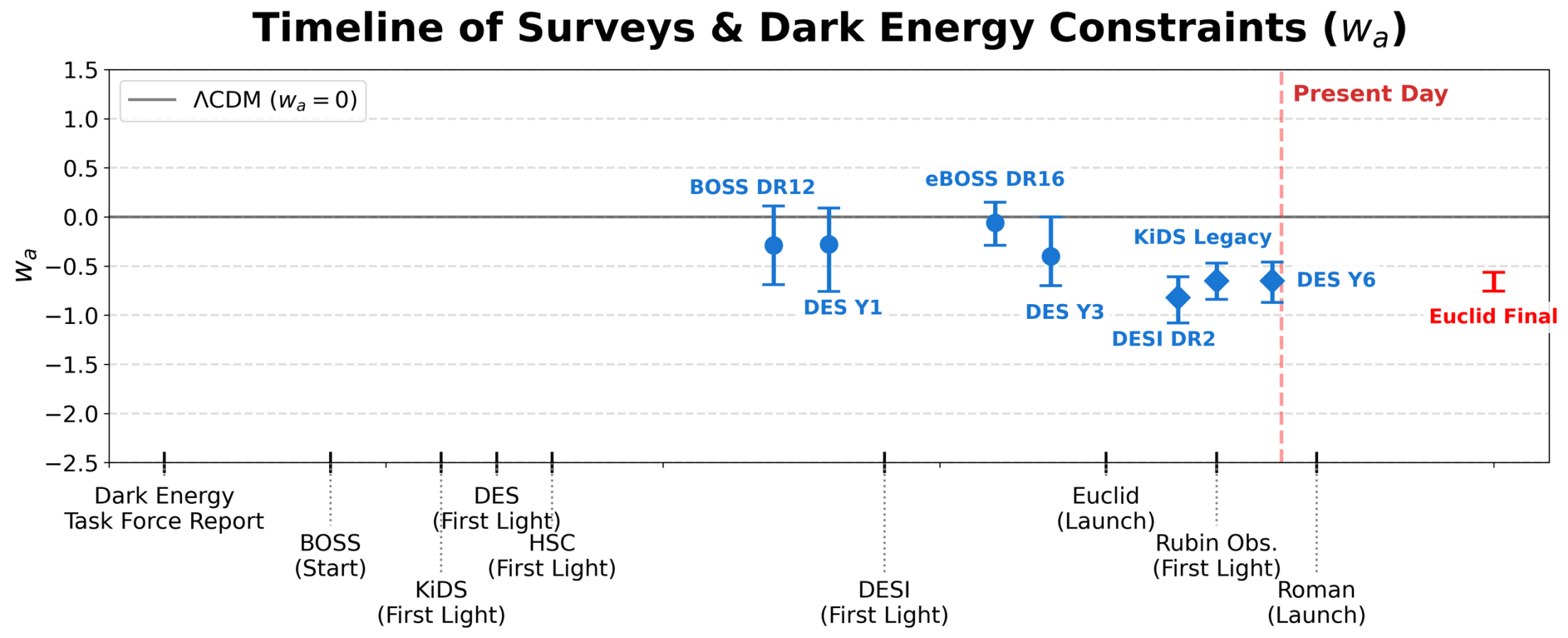

Euclid


Roman


Planck


SPHEREx

What have we been up to?



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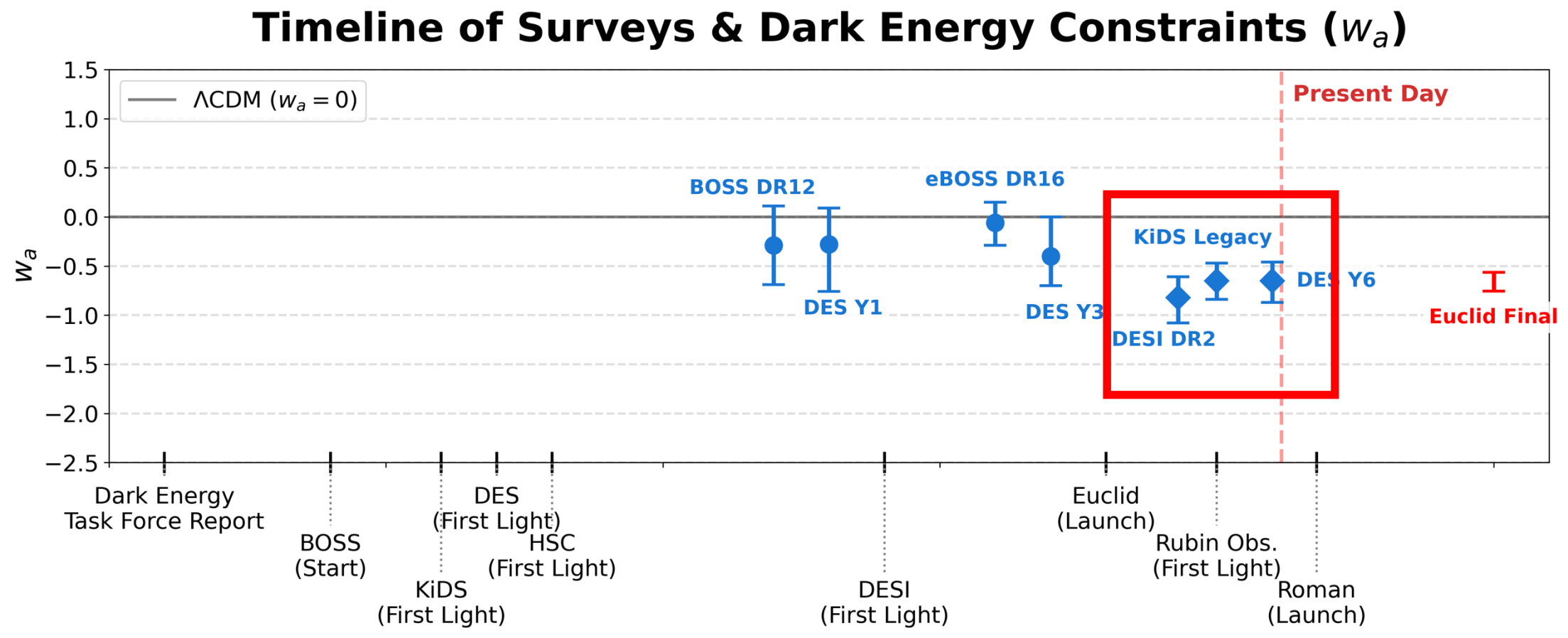

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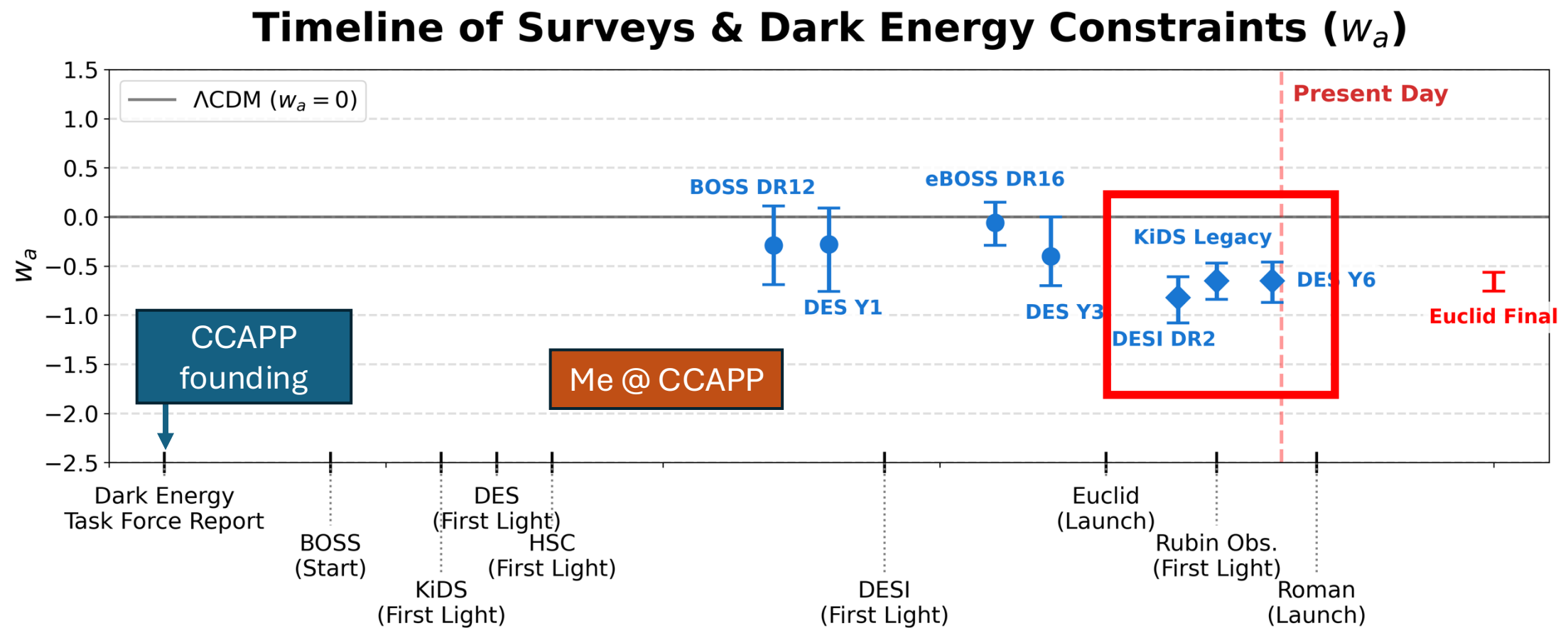

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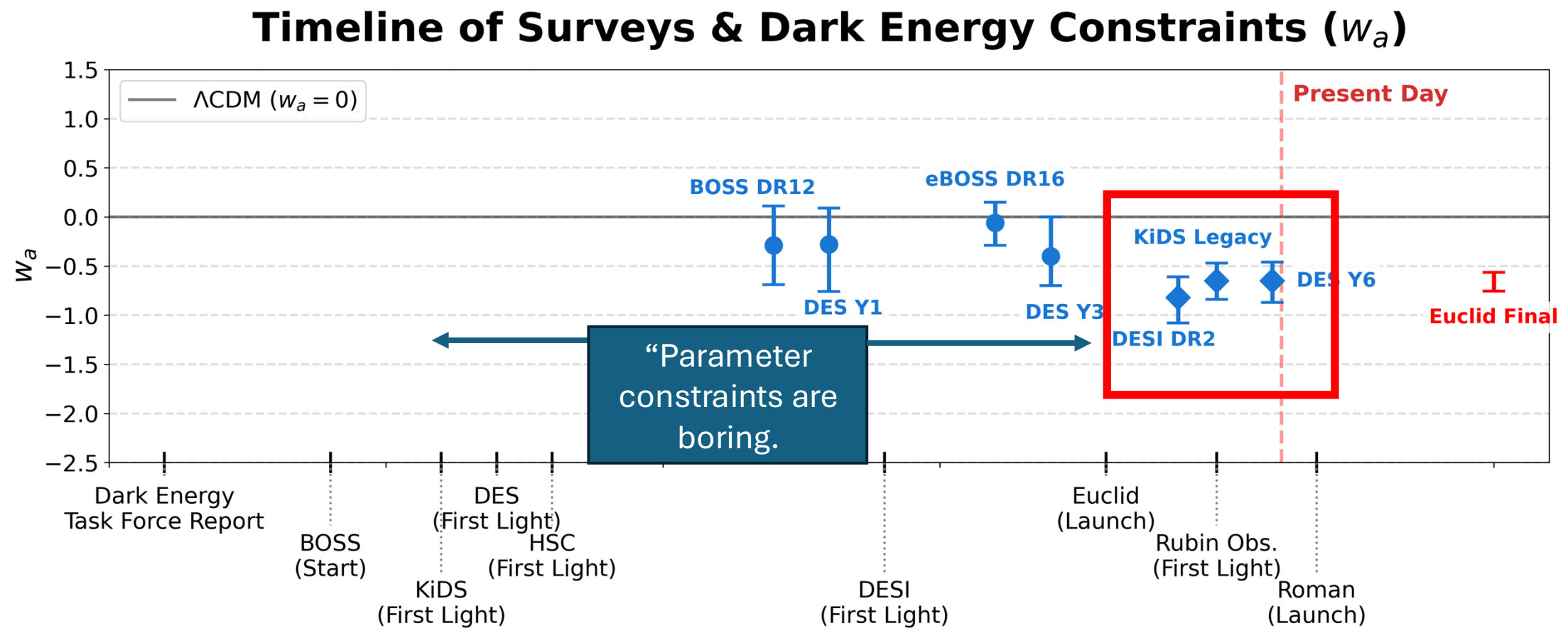

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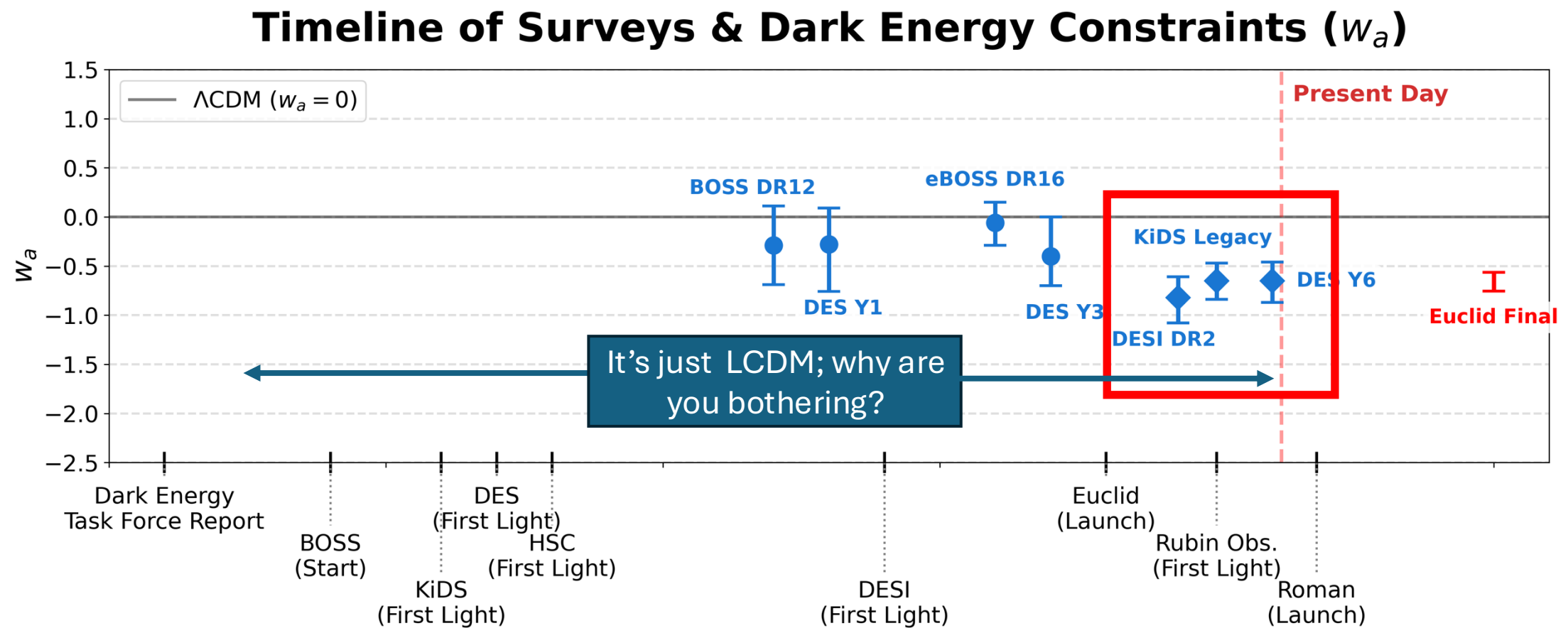

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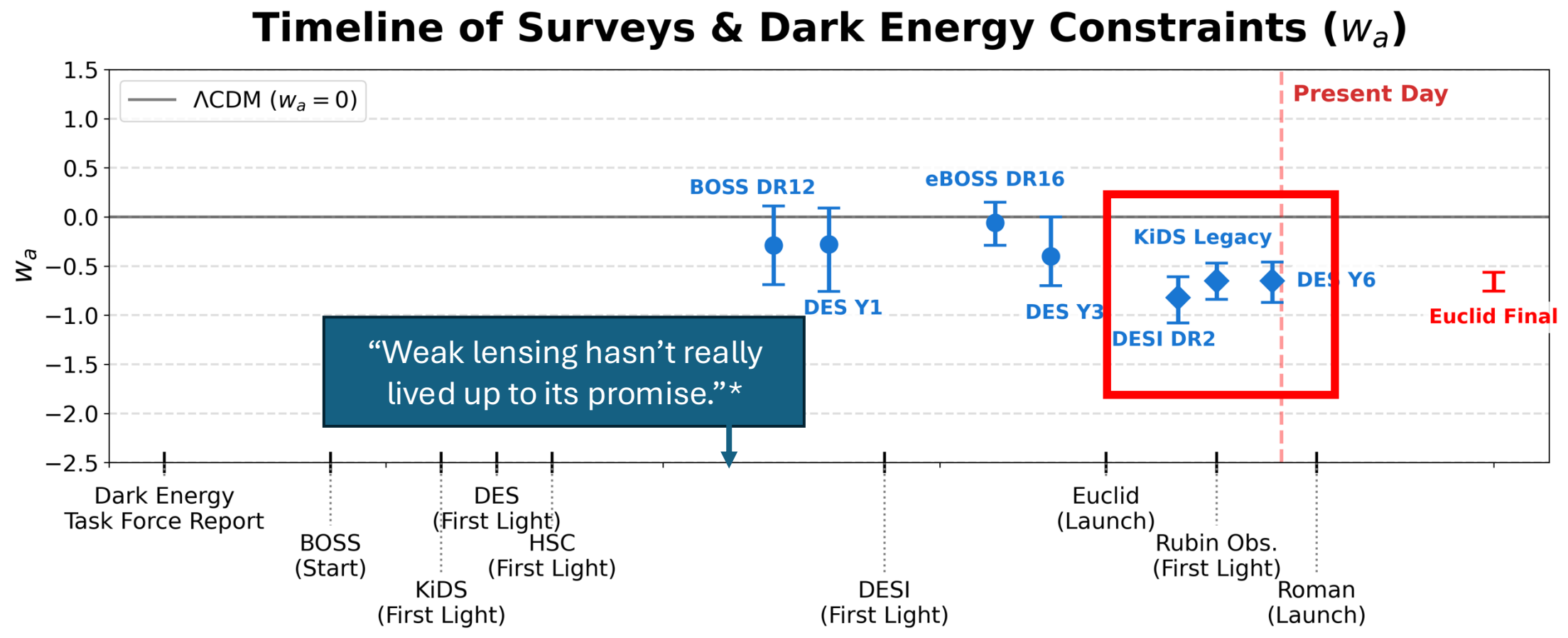
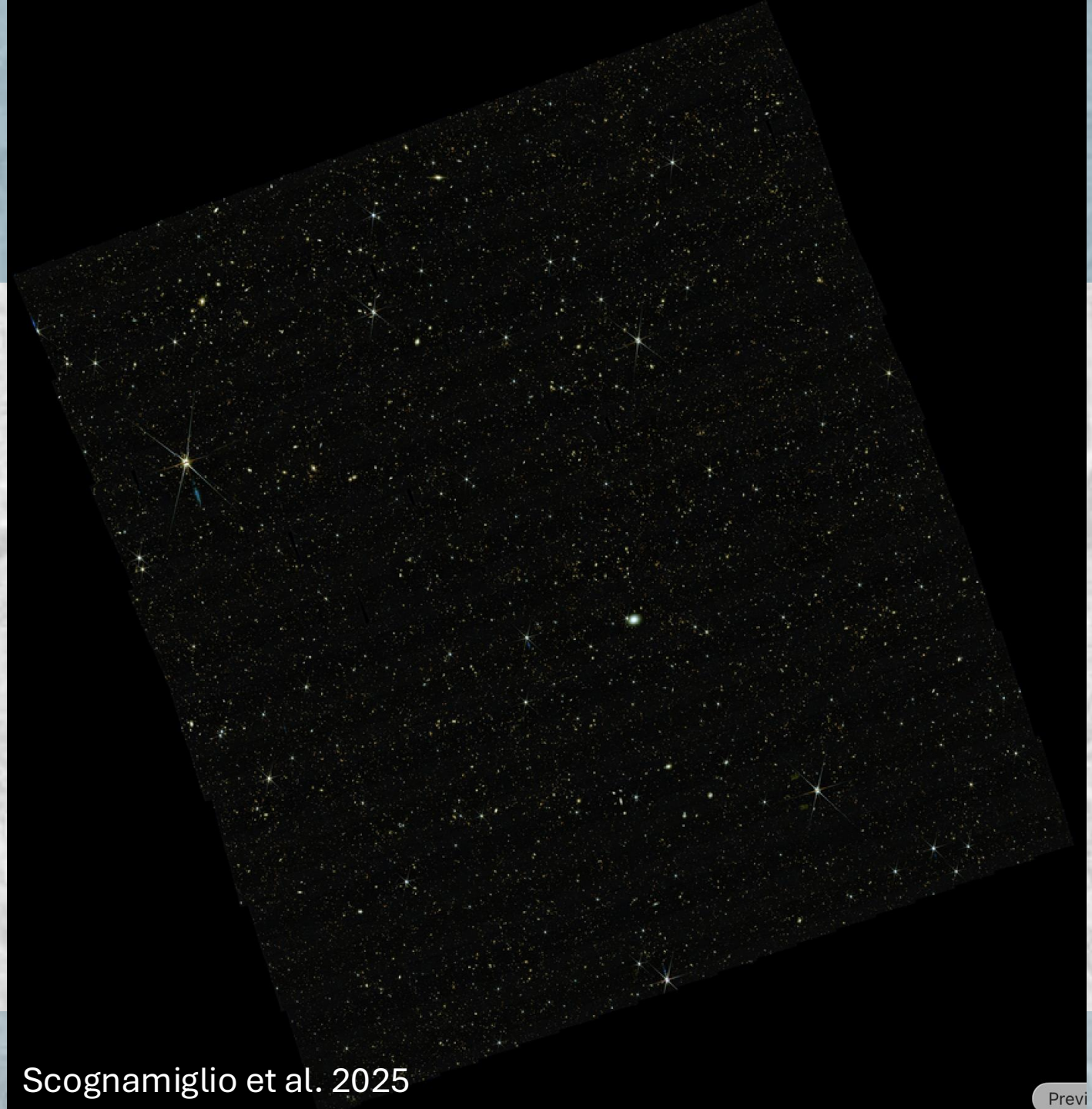
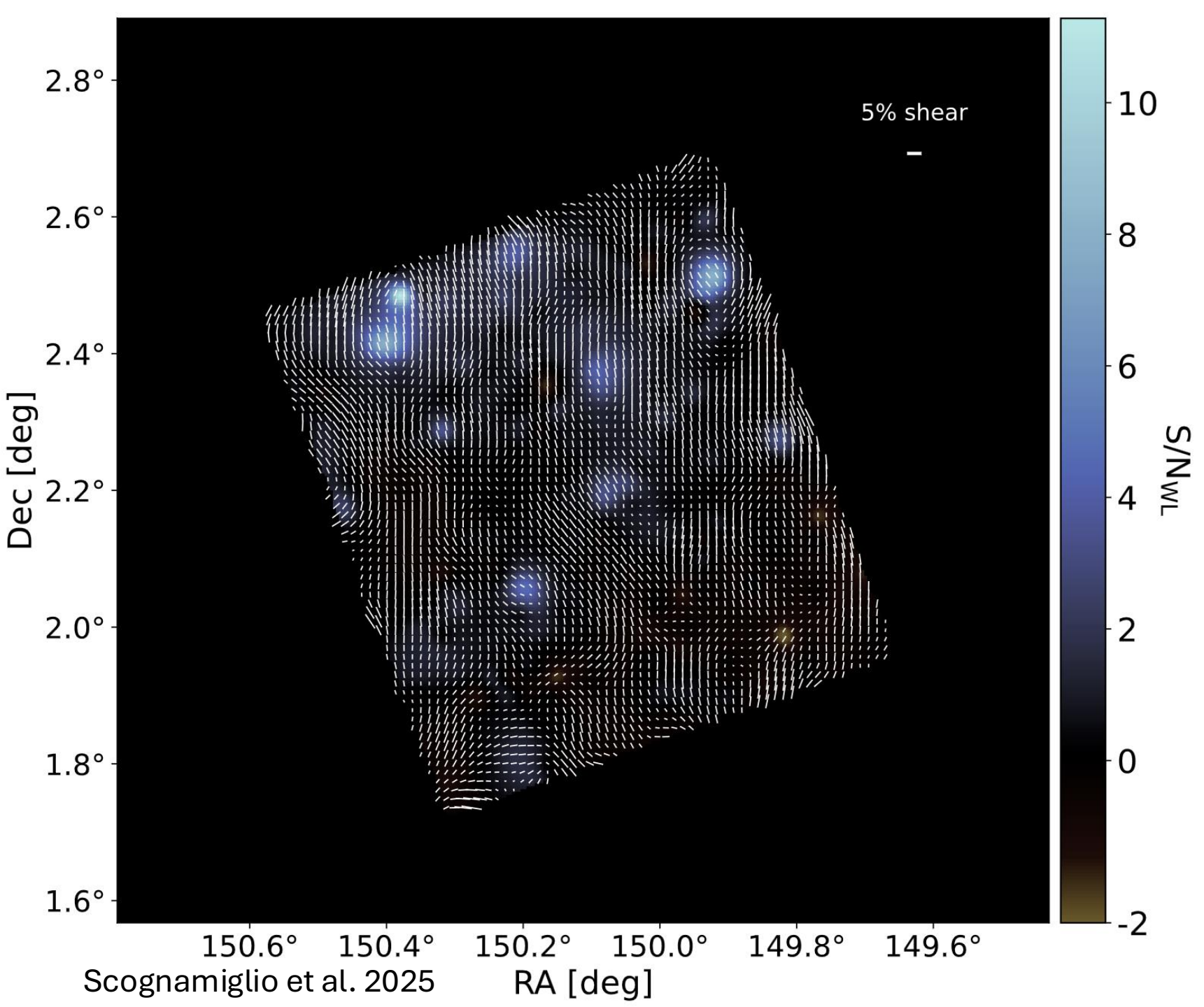


*R. Pogge

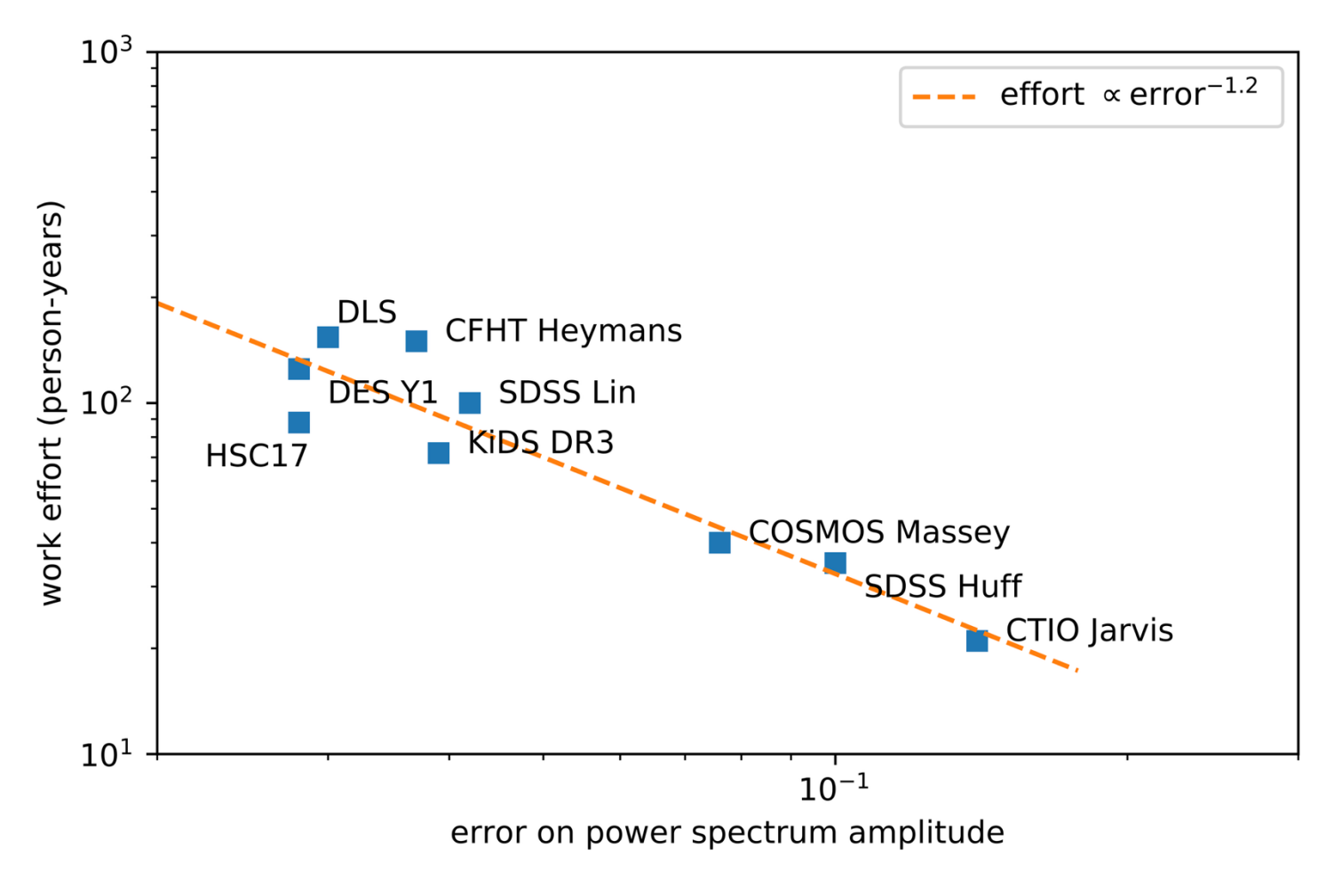


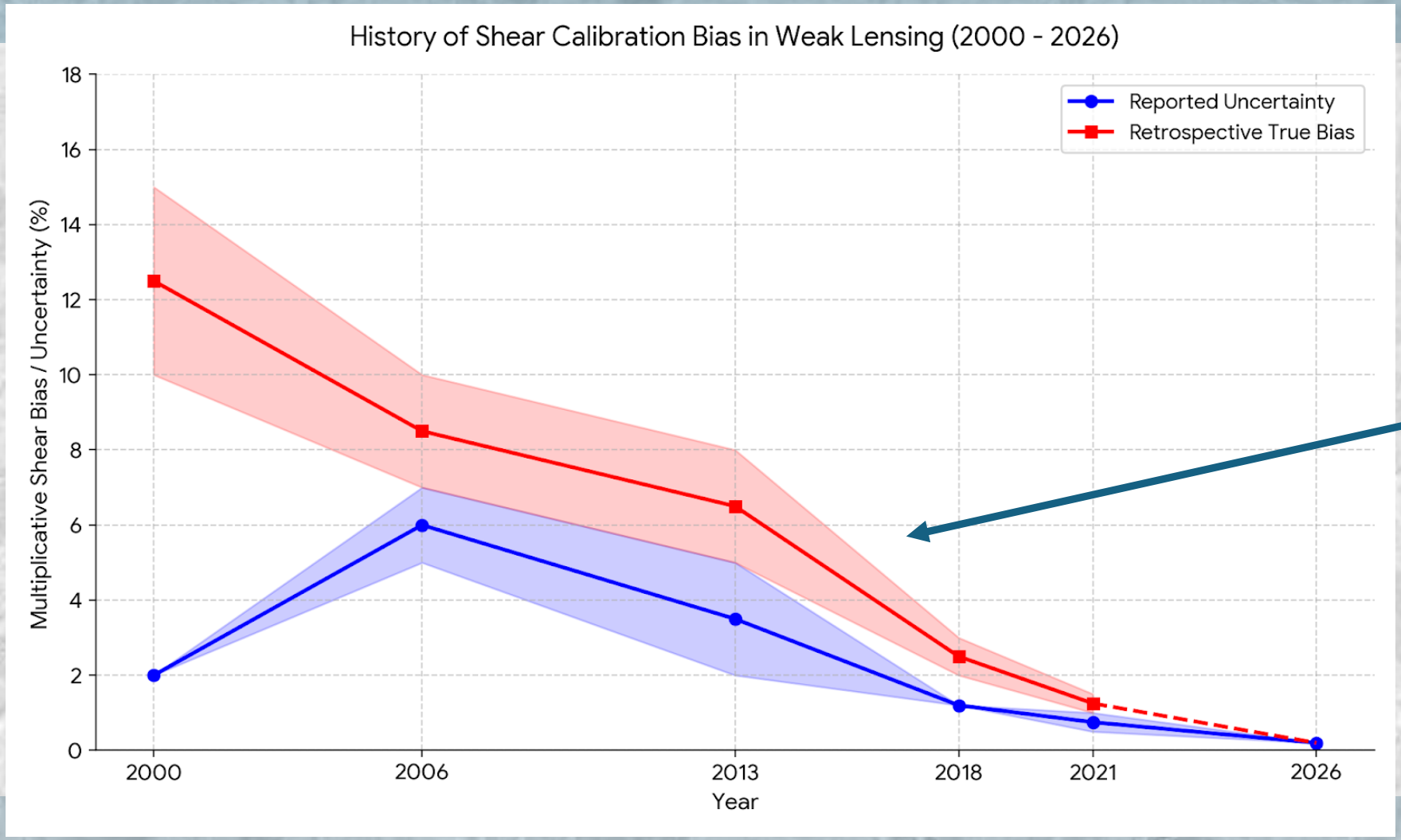
Scognamiglio et al. 2025

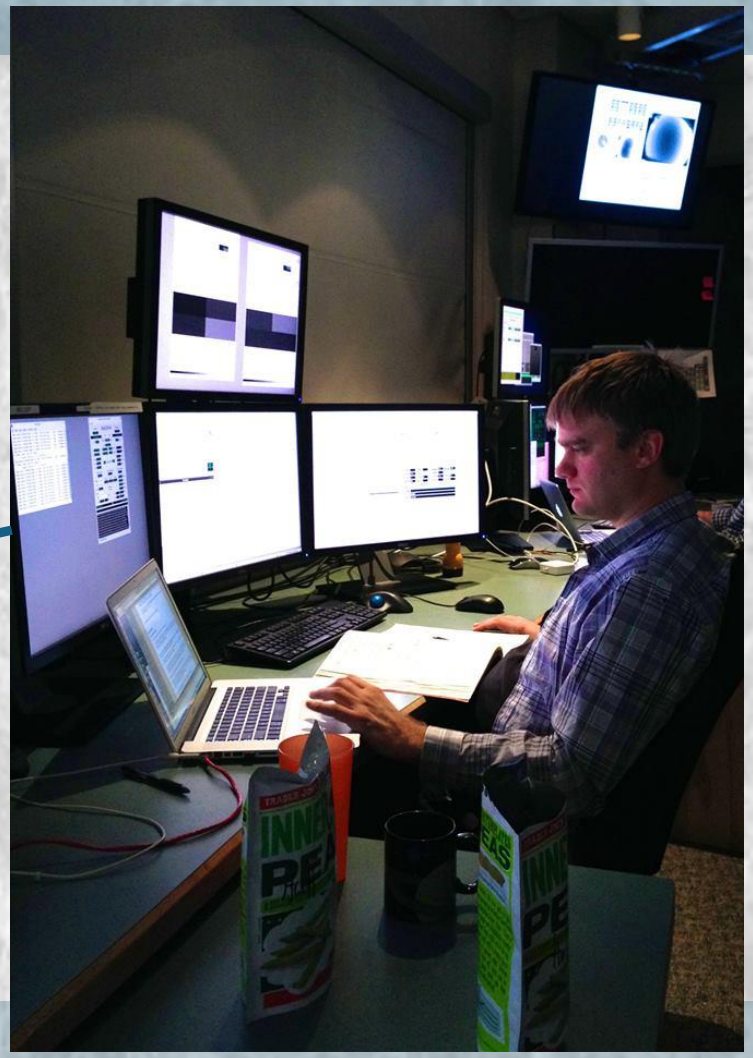


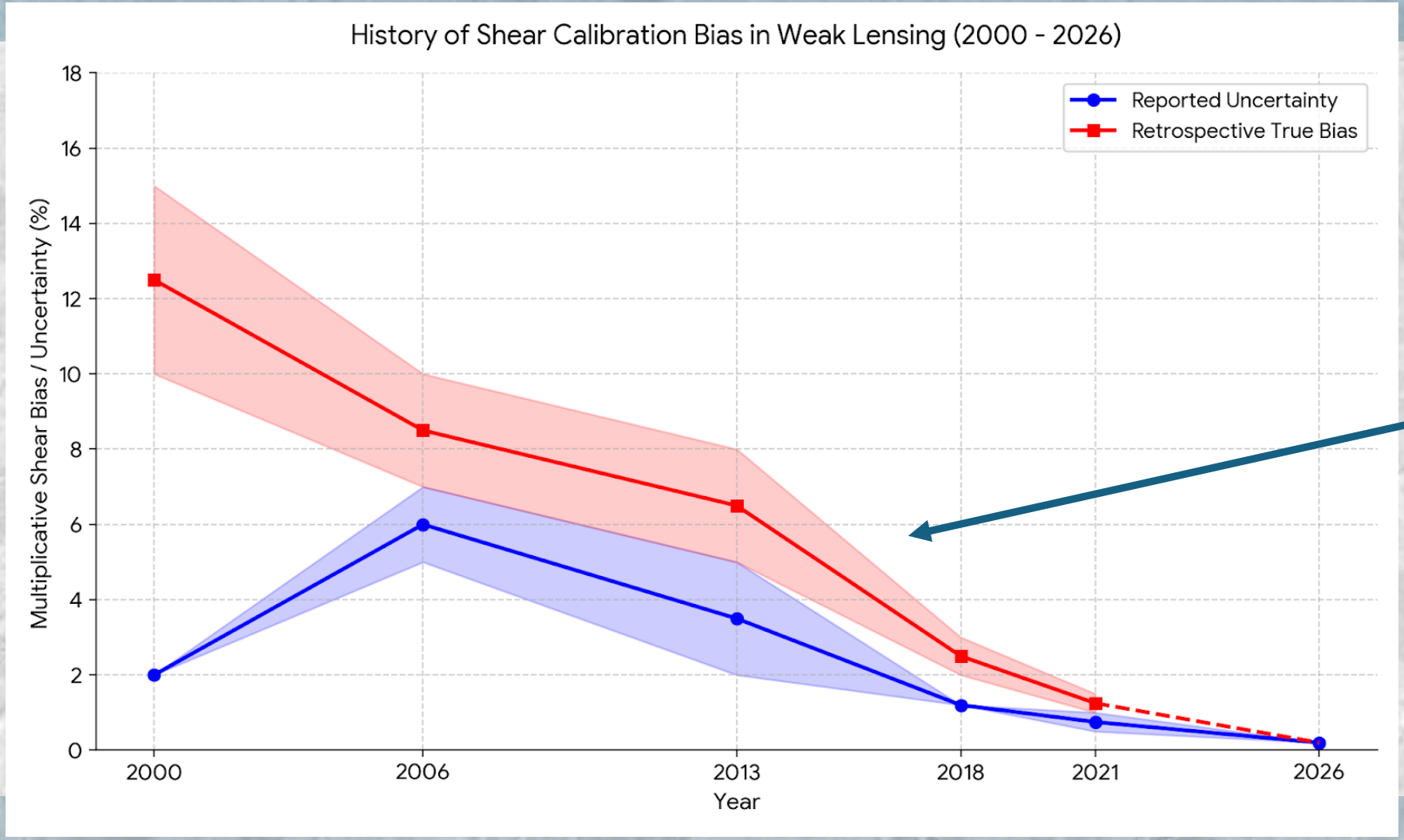
Scognamiglio et al. 2025

What does it take to do a lensing measurement?




History of Shear Calibration Bias in Weak Lensing (2000 - 2026)
Reported Uncertainty
Retrospective True Bias
Multiplicative Shear Bias / Uncertainty (%)
0
2
4
6
8
10
12
14
16
18
2000
2006
2013
2018
2021
2026
Year

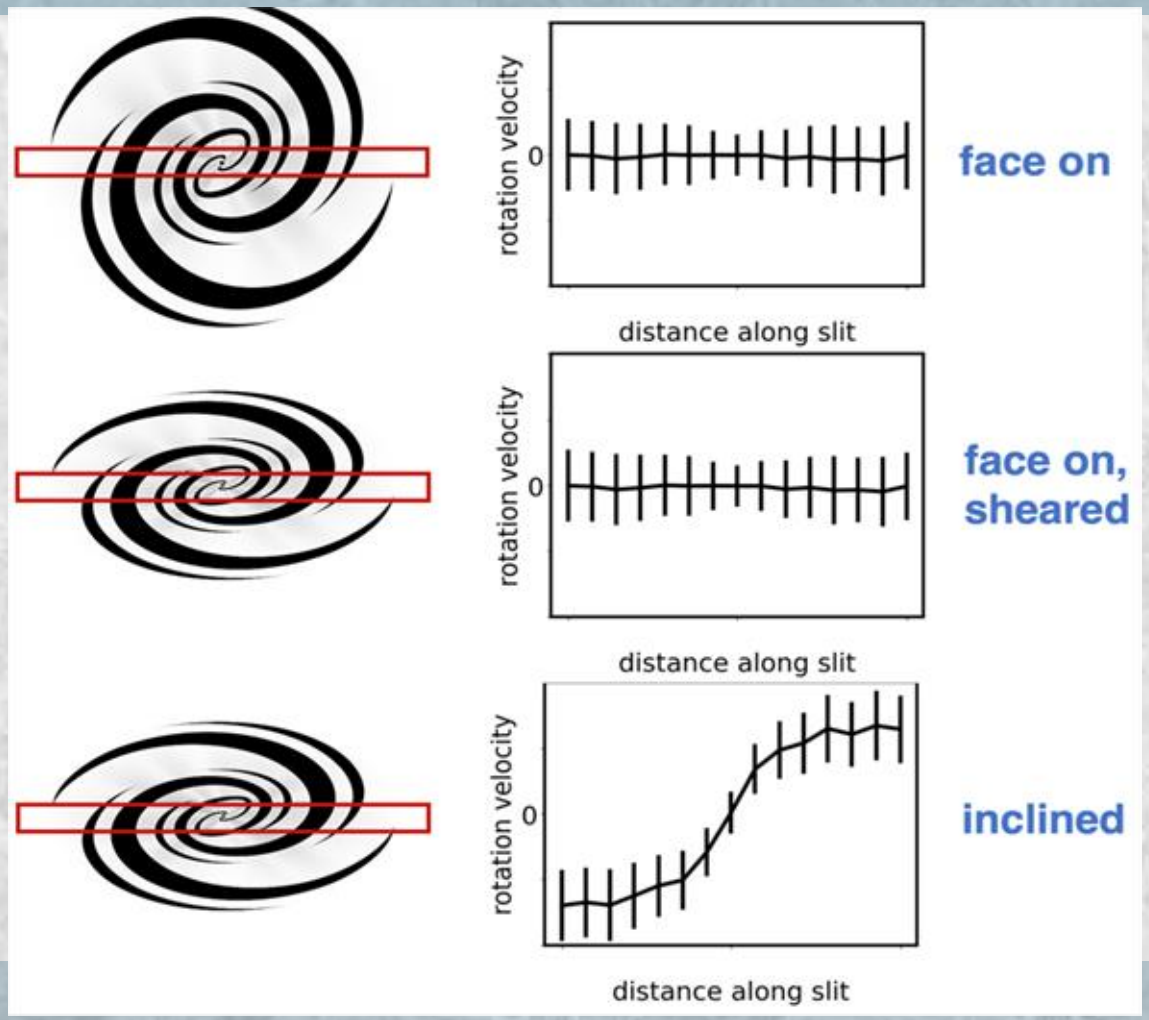




The DES work at CCAPP had a major impact on the slope of this line here.

MetaCalibration, Balrog: algorithms whose descendants now in use across Euclid, Roman, DESI

There has to be an easier way: Kinematic Weak Lensing



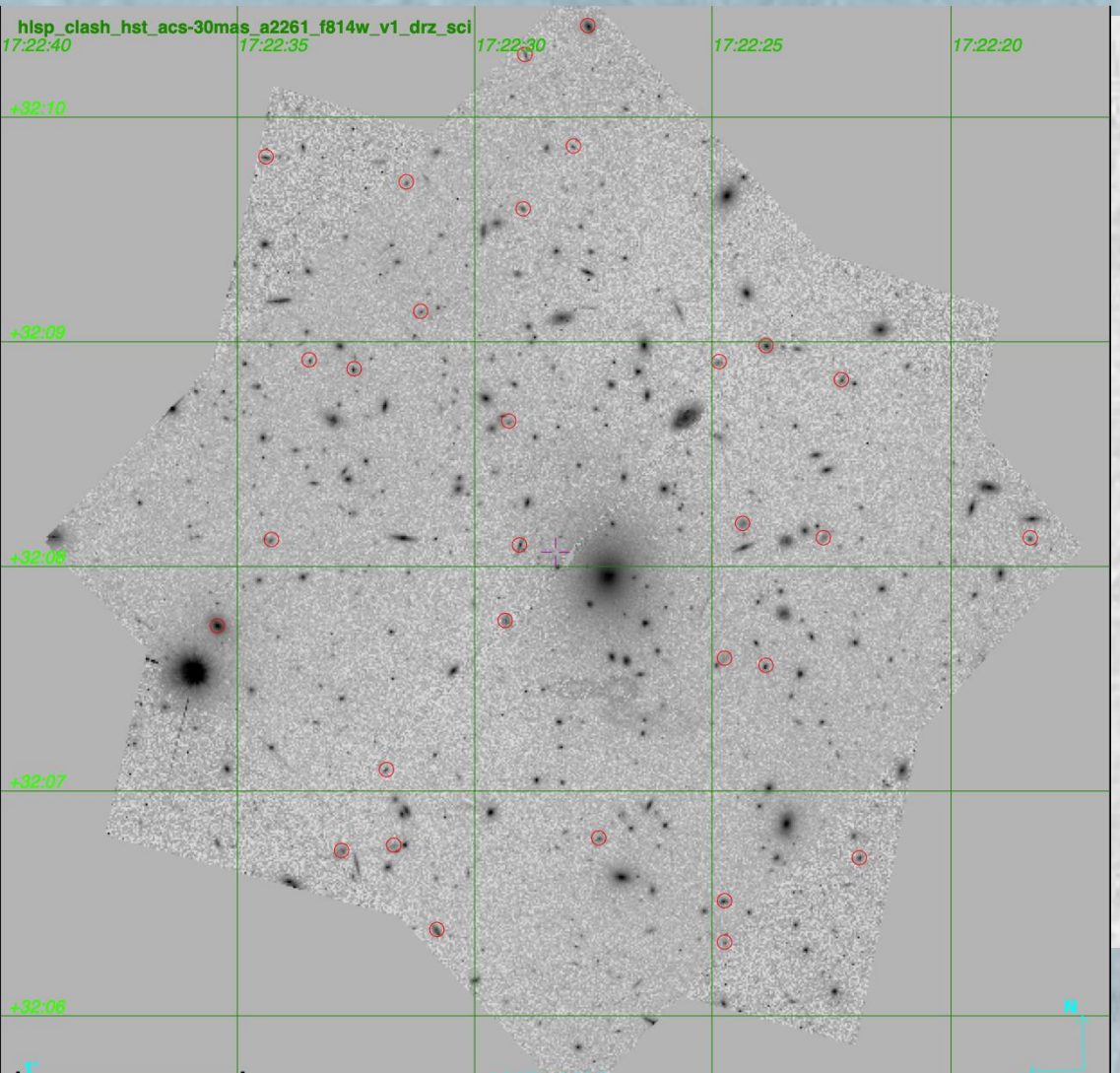
Most of the shape noise comes from the random orientations of galaxies.

Normally shear and shape are degenerate, which means we have to measure lensing from many galaxies

But the kinematics can tell you the shape.

This should reduce the shape noise in lensing by an order of magnitude.

There has to be an easier way: Kinematic Weak Lensing

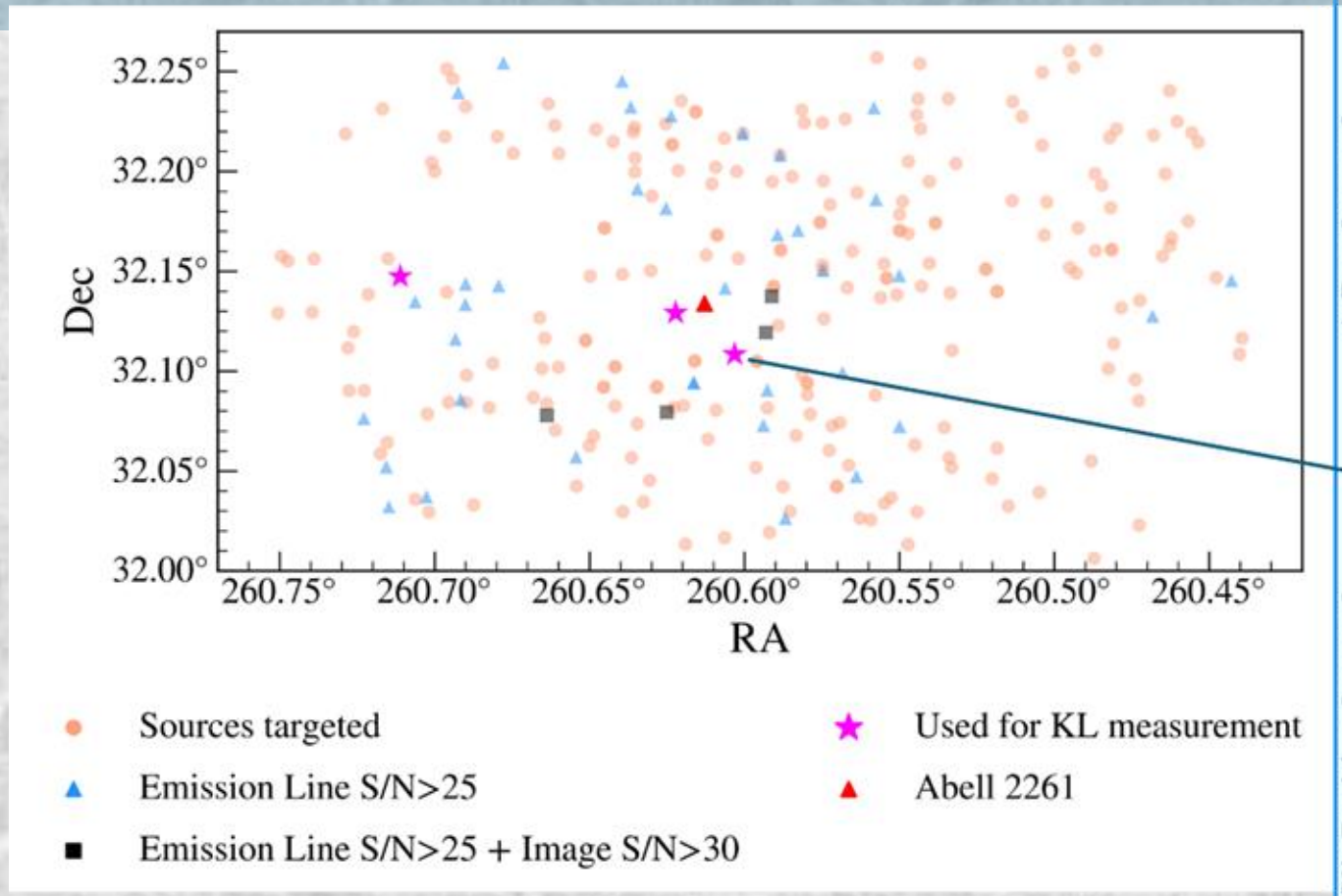


Pick massive galaxies behind a cluster.

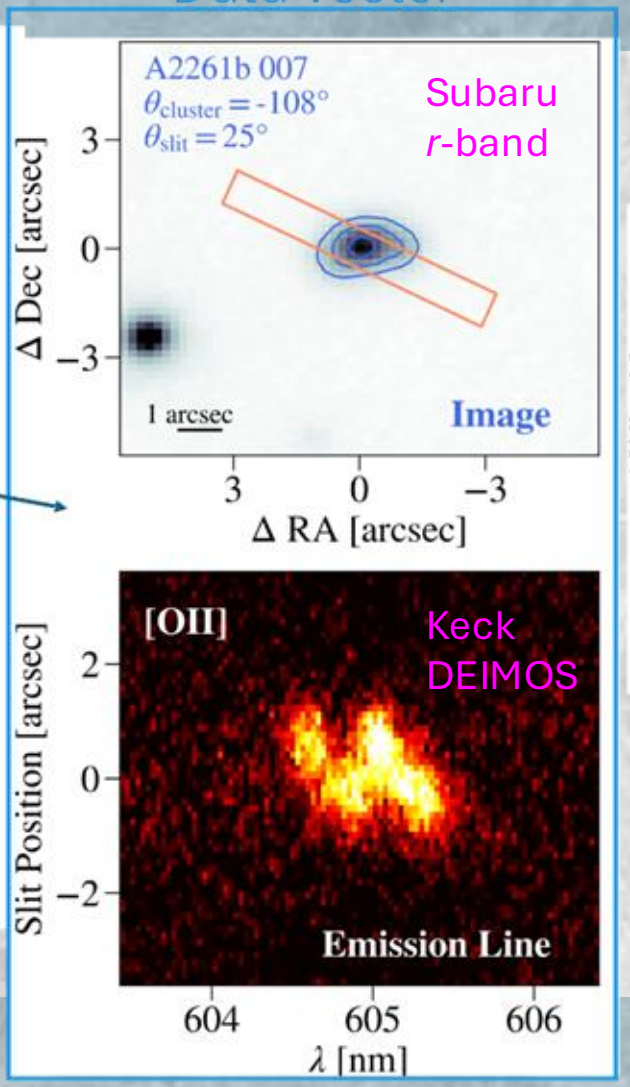
Take spectra, fit for the usual (rotation speed, shape, orientation, etc.) +weak lensing shear

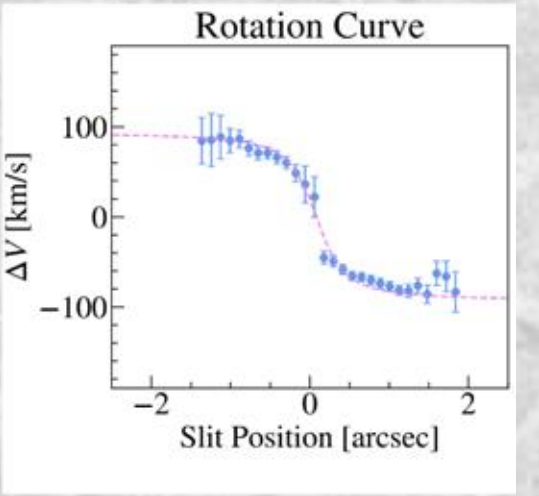
Pranjal R.S.

A Cluster KL Measurement with Abell 2261



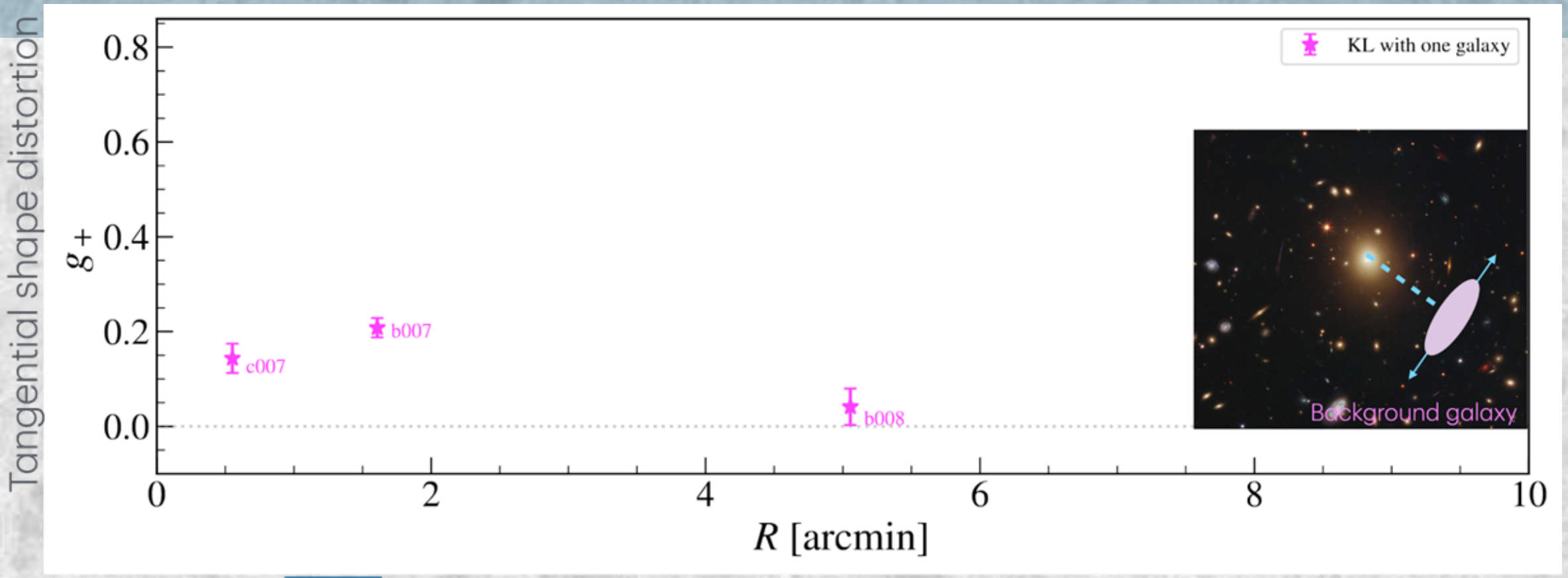
Data vector





Pranjal RS+2025

A Cluster KL Measurement with Abell 2261

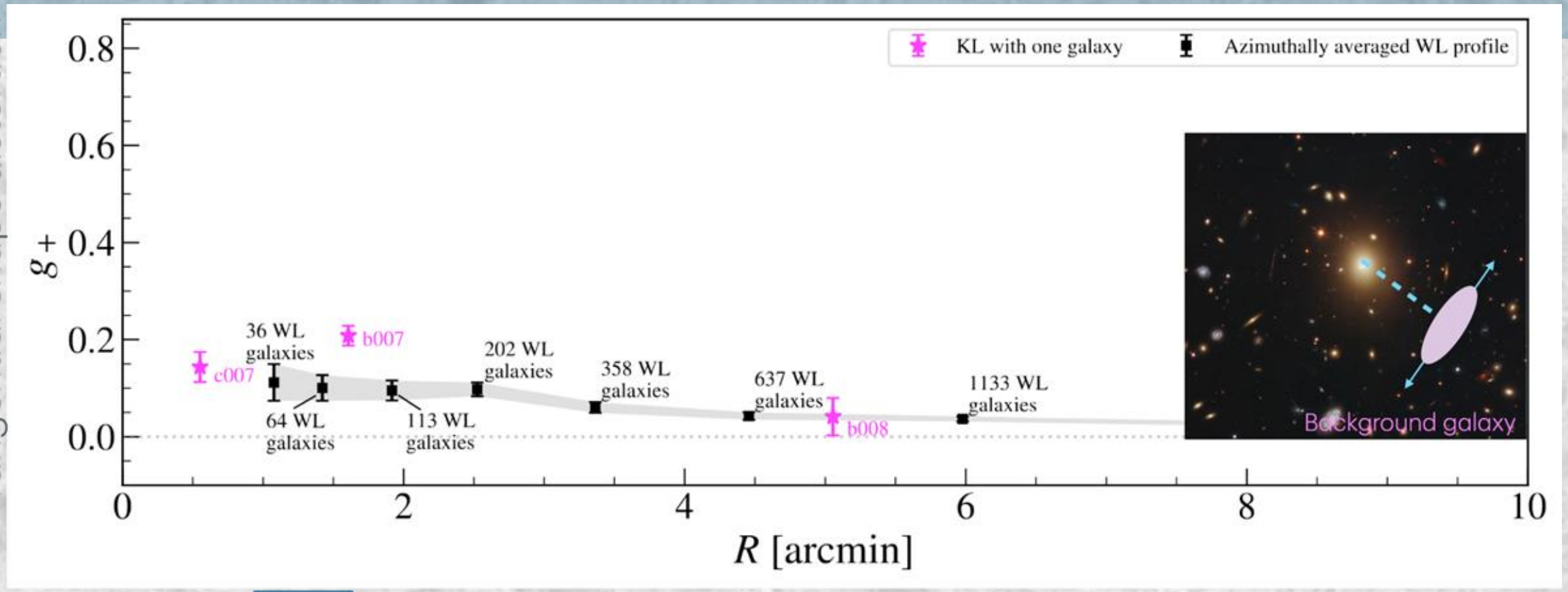


b007: $g_{+,\mathrm{KL}} = 0.208 \pm 0.020.$
b008: $g_{+,\mathrm{KL}} = 0.041 \pm 0.038.$
c007: $g_{+,\mathrm{KL}} = 0.144 \pm 0.030.$

Measured KL shear uncertainty meets expectations!

Pranjal RS+2025

A Cluster KL Measurement with Abell 2261



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Measured KL shear uncertainty meets expectations!

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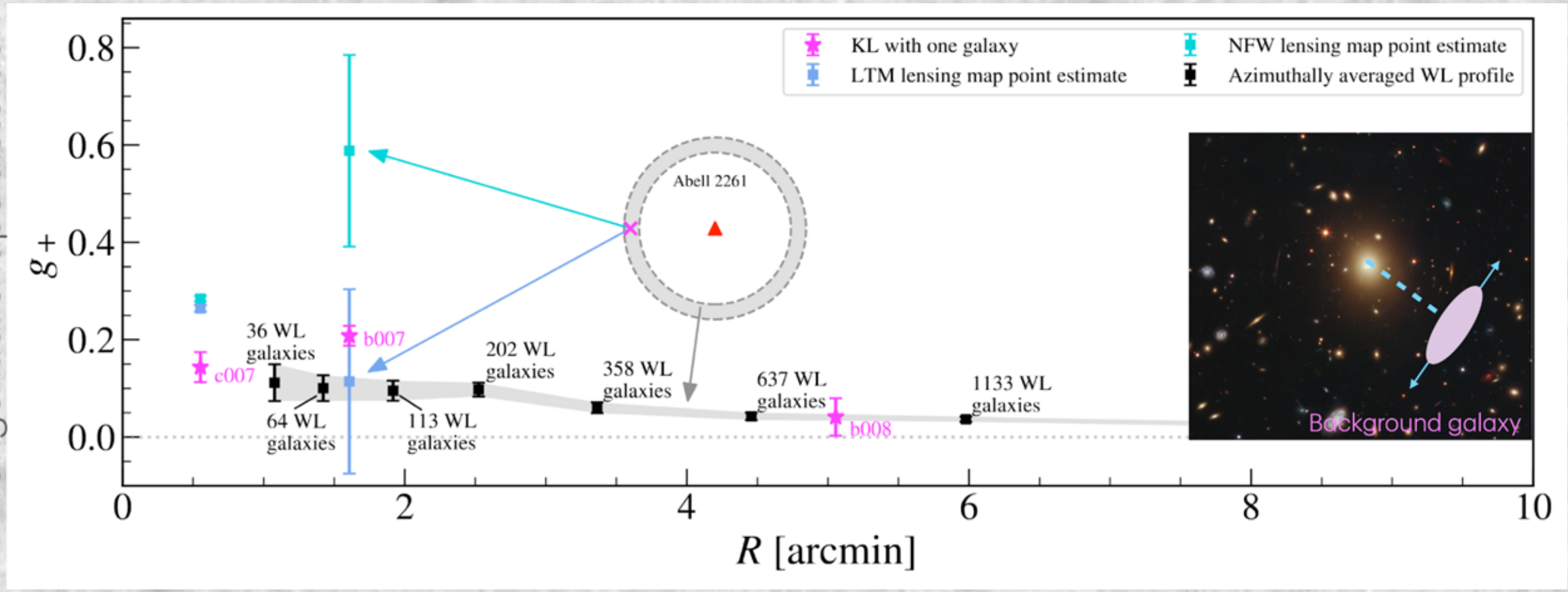
WP 2: Precursor Keck - Pilot Cluster KL Measurement with Abell 2261



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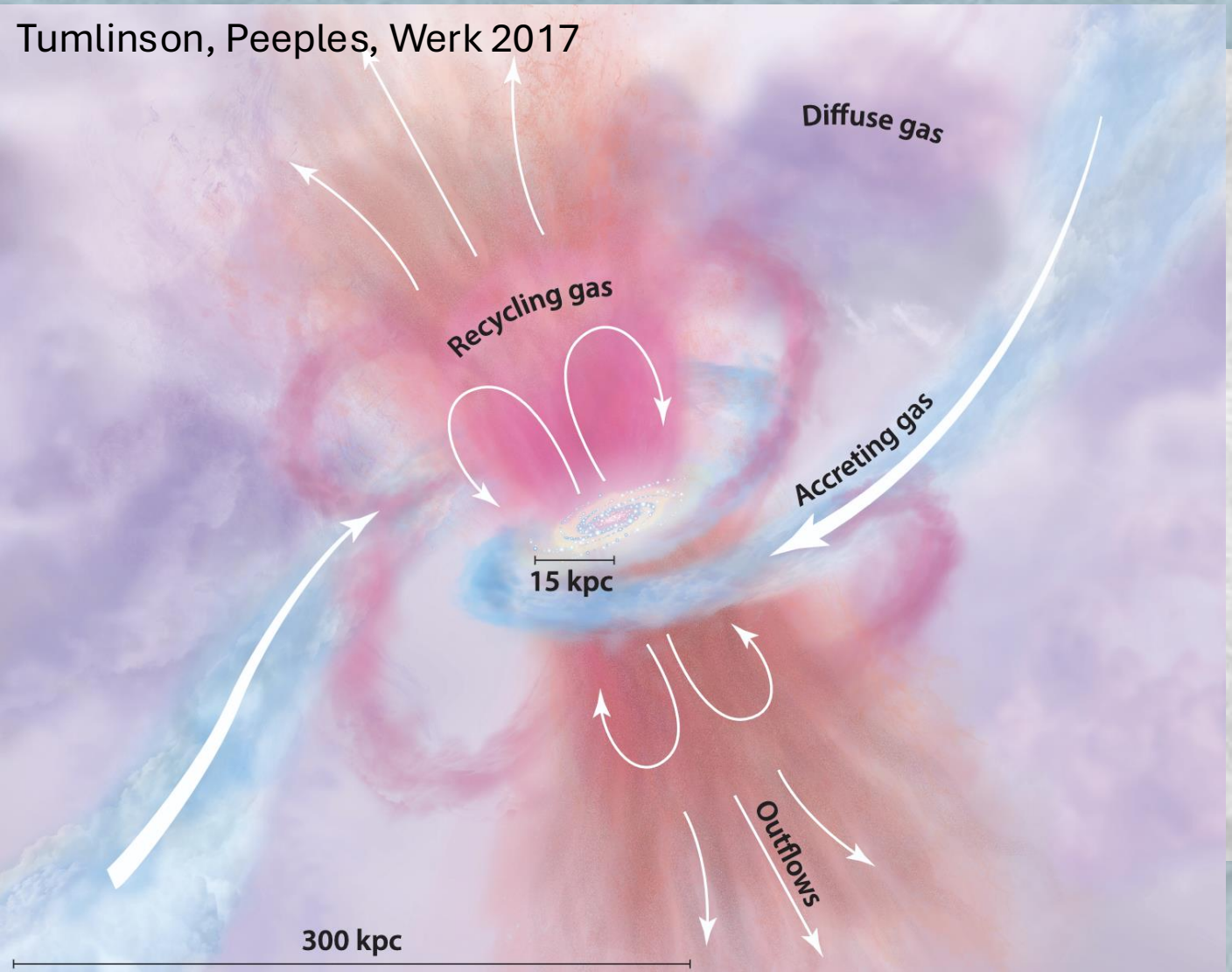
KL with Roman

- There is a CCAPP-heavy team at JPL and Arizona currently building a measurement pipeline to do KL with Roman.
- If it works as well as it seems to, we will be able to detect a uniquely powerful lensing signal with Roman
- This is a particularly promising probe for doing cosmology in the generation after Roman.

And now for something quite different:

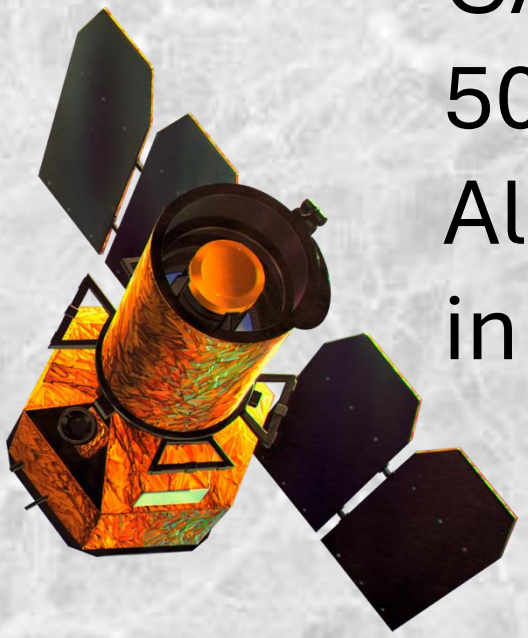


Important features of galaxy evolution seem to be driven by diffuse circumgalactic gas that we can't see.

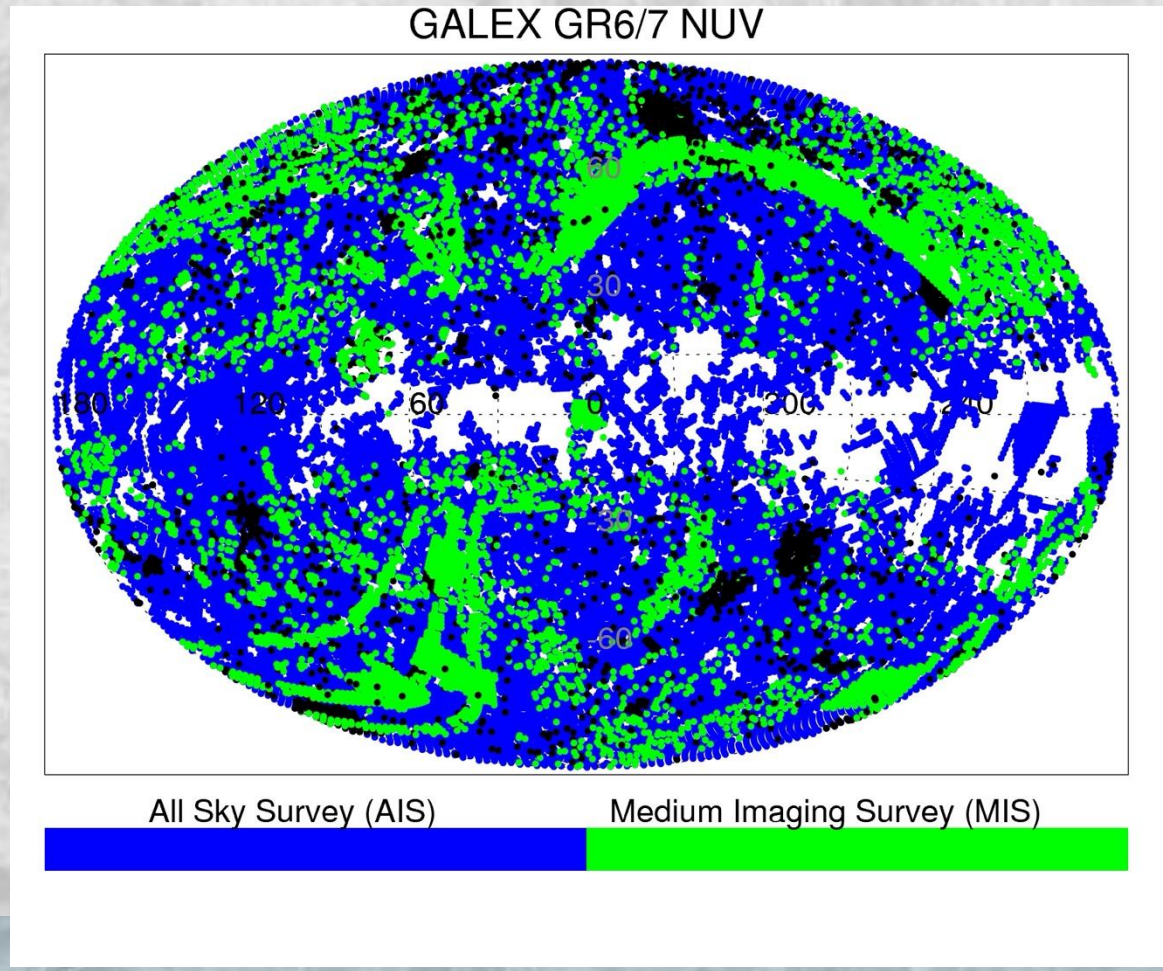
The temperature of this gas is such that it emits in the UV.

It is detected in absorption, but except very close to the host galaxy, it is mostly invisible in emission.

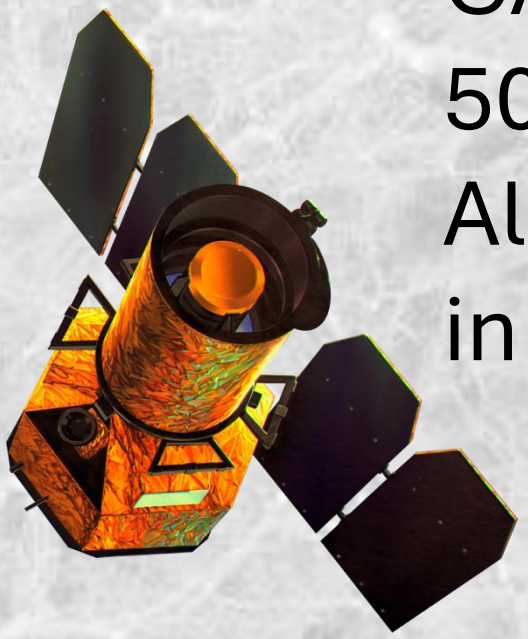
The CGM is potentially detectable in an existing mission!



GALEX:
50cm UV telescope
All-sky imaging survey
in 2 bands

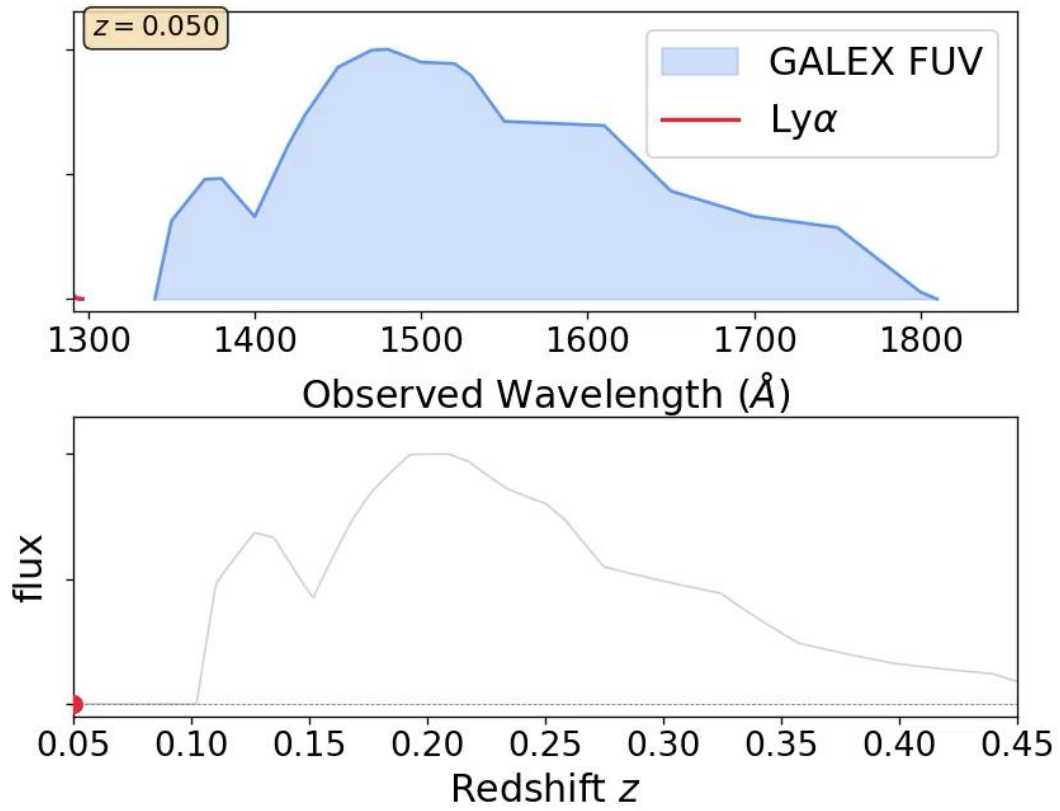


But there’s just one problem:



GALEX:
50cm UV telescope
All-sky imaging survey
in 2 bands

Integral-field Spectra from Broadband Imaging



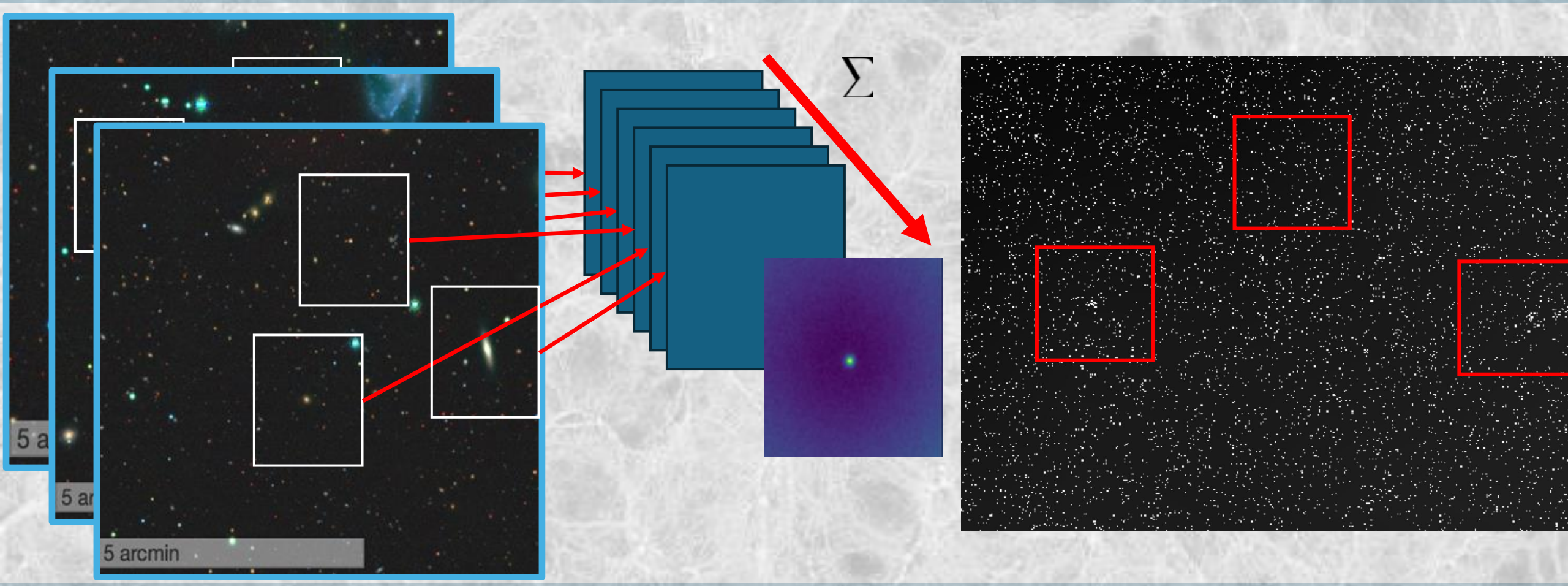
Most of the CGM is hydrogen

We expect the dominant signal to be the Lyman alpha line from neutral hydrogen

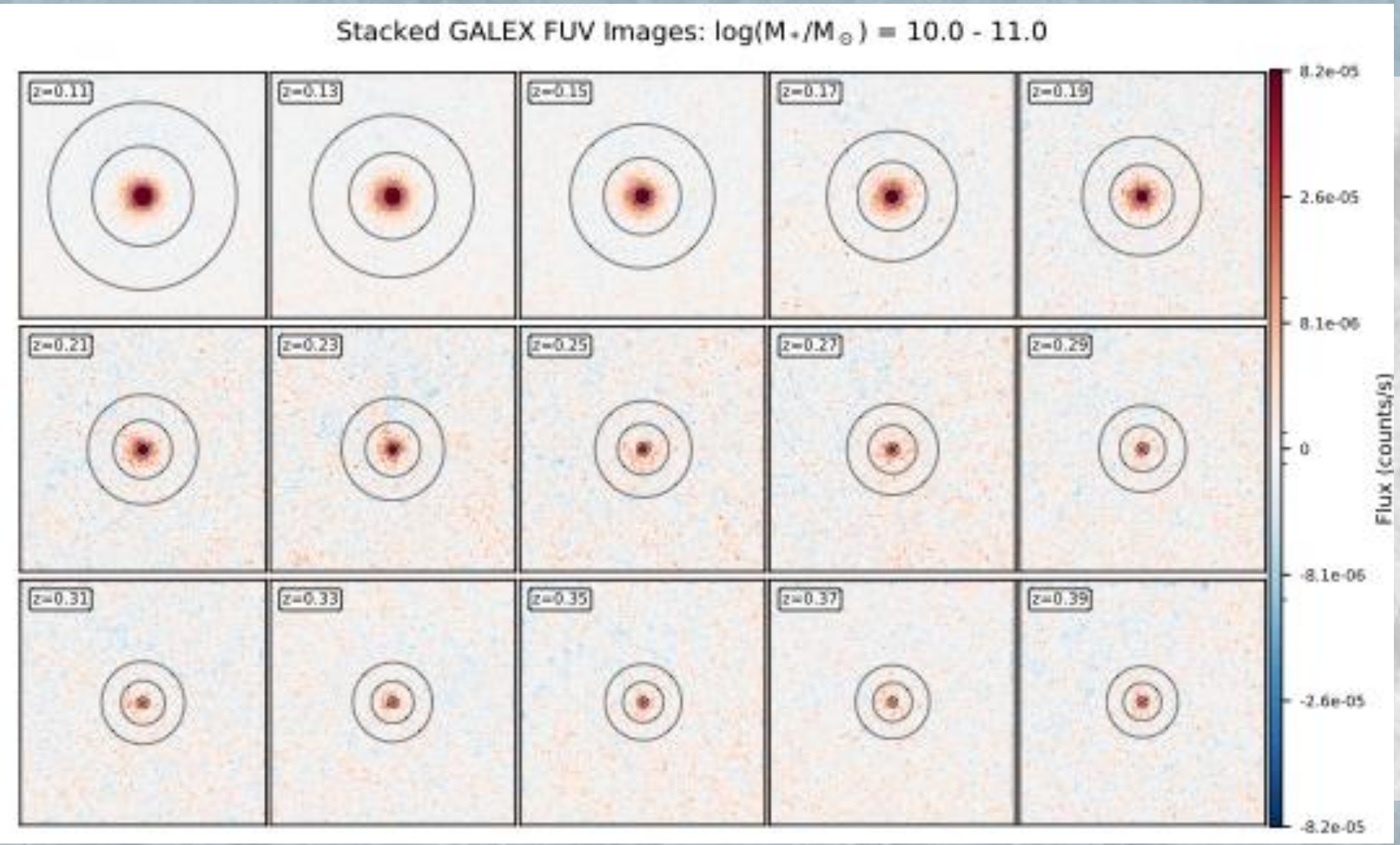
But if there are other features, it would be nice to be able to distinguish them.

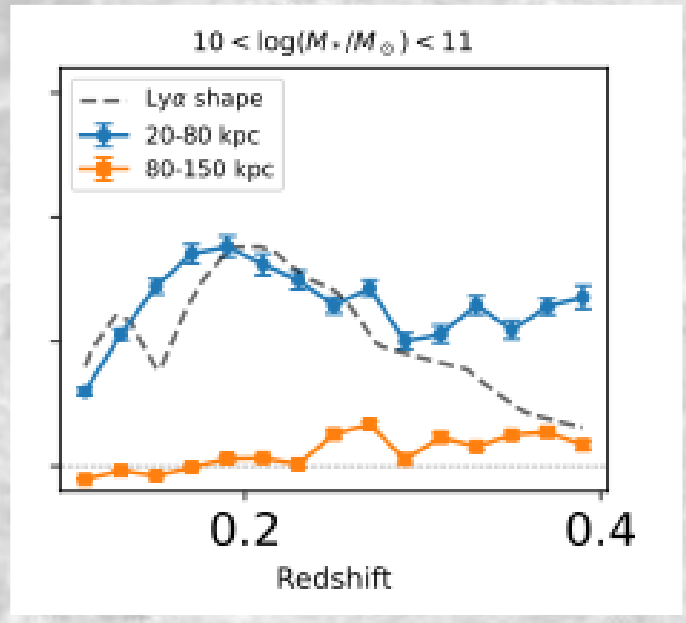
We'll stack in narrow slices in redshift, and take advantage of what we know about the GALEX filter shape to pick out known emission lines.

We find galaxies with known redshifts in SDSS, and pick out their images in GALEX



Stacked GALEX FUV images of SDSS sources





Building a research group after CCAPP

- John opened by talking about community, a multidisciplinary approach, and a flat hierarchy.
- This is what I've found myself trying to build at JPL.
- It takes a long time. I don't have any reason to think we'll ever achieve what you have here, but it's useful to have a compass.

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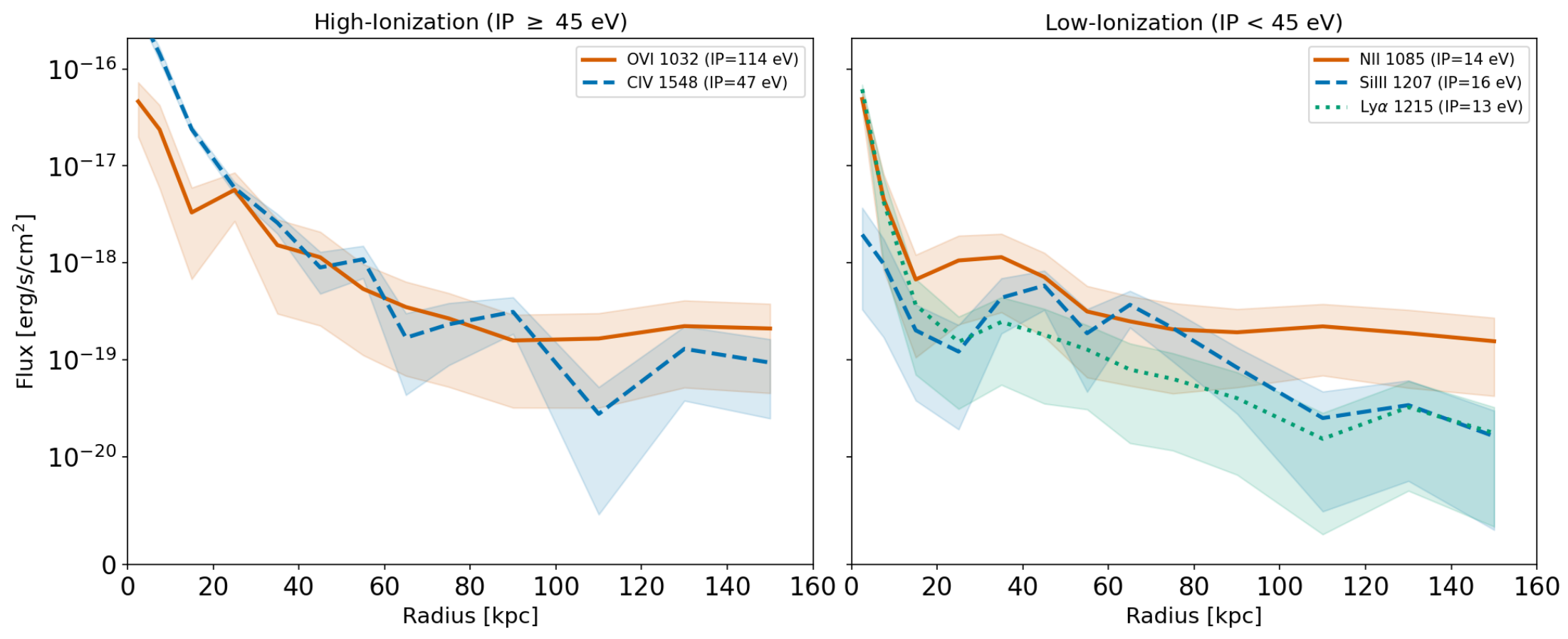
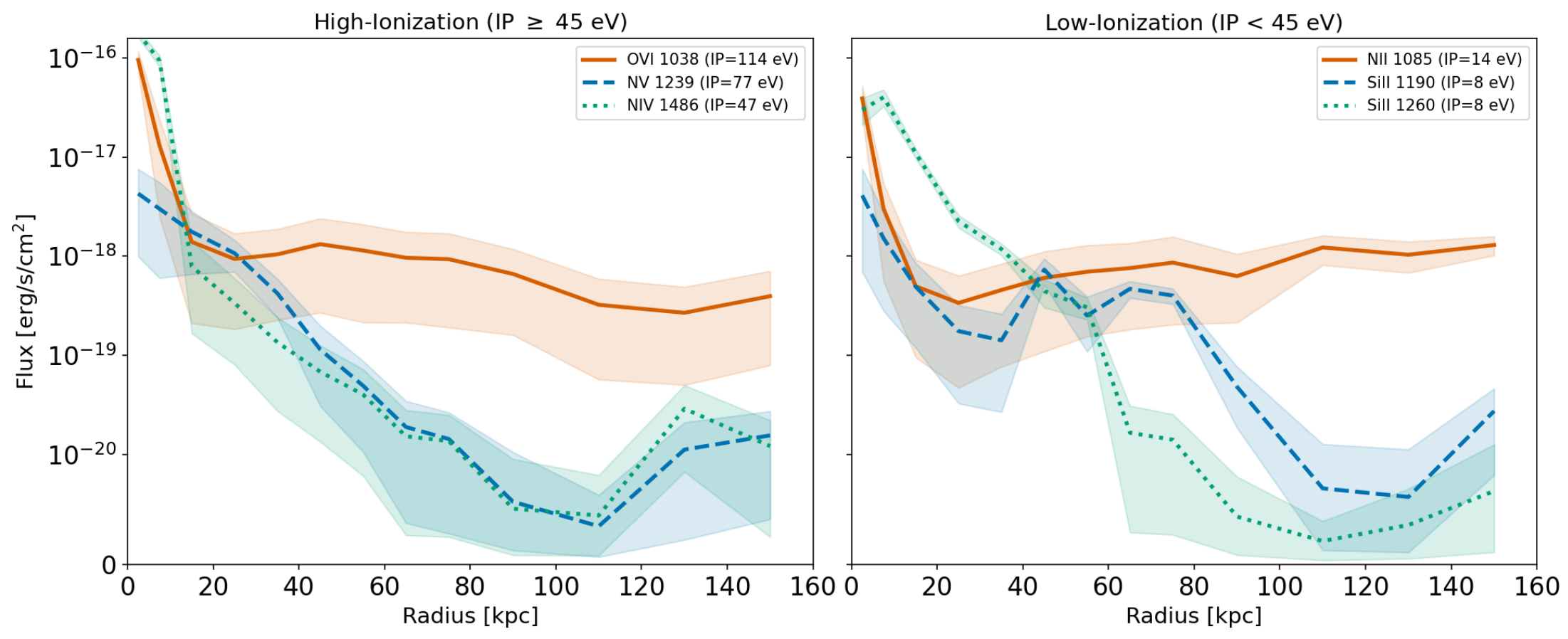
Ions: Low Mass ($9 < \log_{10} M_* < 10$)



Ions: Intermediate Mass ($10 < \log_{10} M_* < 11$)



Ions: High Mass ($11 < \log_{10} M_* < 12$)