Intensity Mapping Tomography: Method and Application to Data

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Broadband intensity mapping?

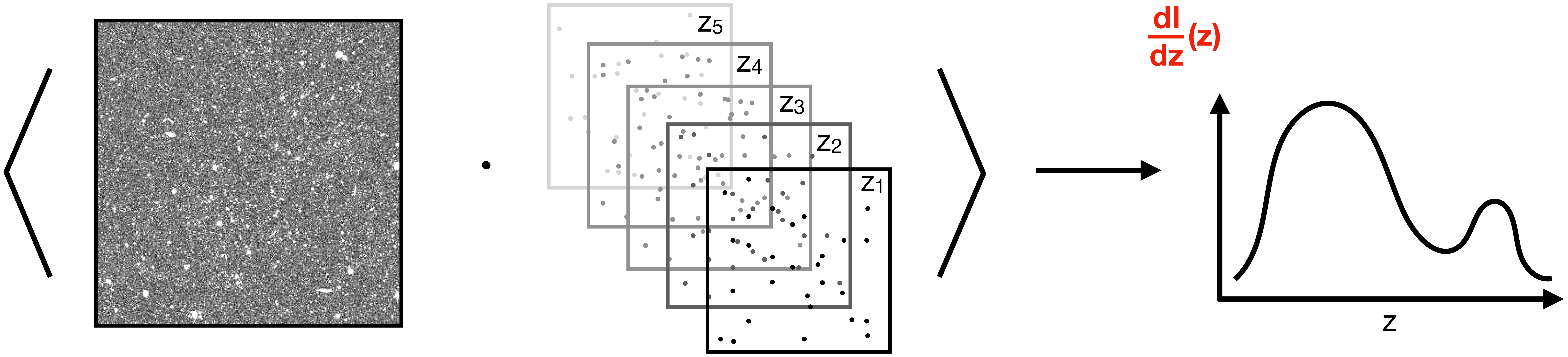
- **Potential:** unlock the use of diffuse light in the rich legacy of sky surveys
- **Challenge:** frequency information is largely lost, **$R = \lambda/\Delta\lambda \sim 5$**

  more foregrounds, junk, and redshift projection ⟶ **intensity mappers' nightmare**

How can we deal with foregrounds, junk & redshift projection?

$$w_{Ir}(z) \propto \boxed{\frac{dI}{dz}(z)\, b_I(z)}\, b_r(z)\, w_{DM}(z)$$

intensity map $I(\phi)$ | **r**eference galaxies or quasars | redshift deprojected intensity

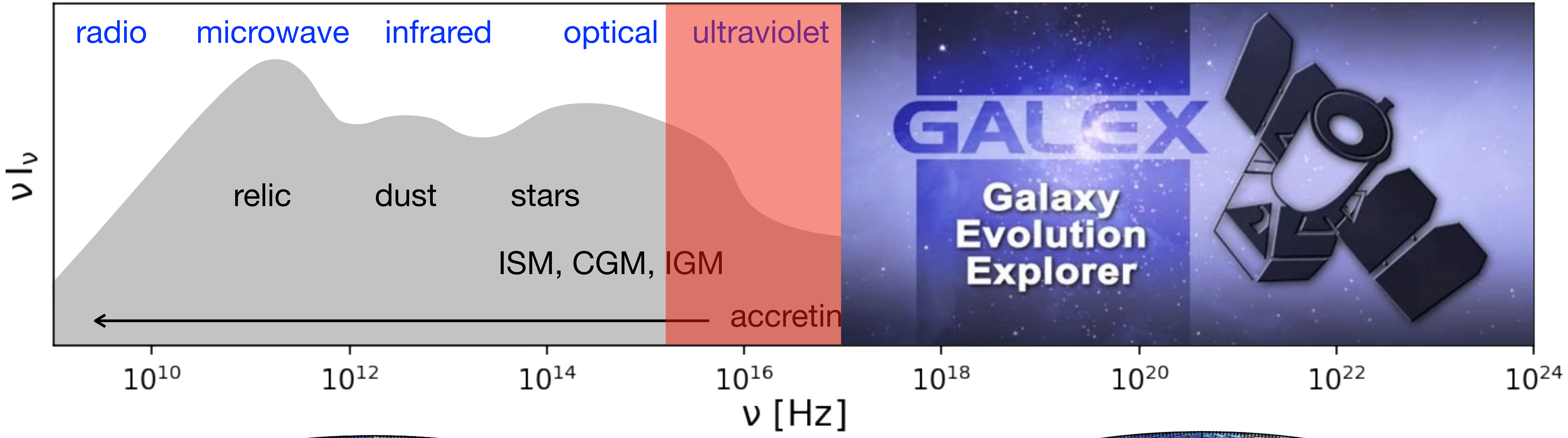


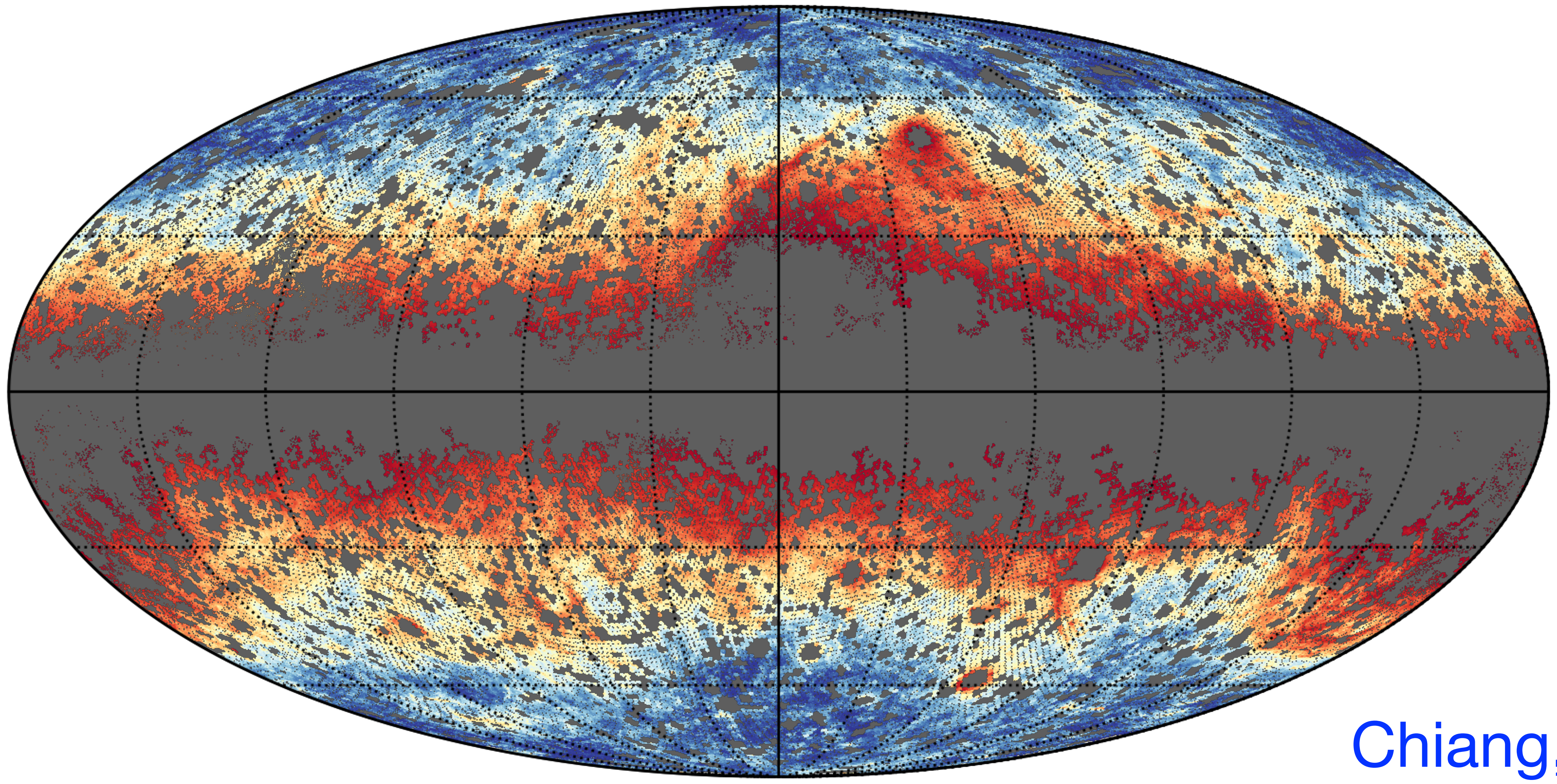
clustering redshift estimation

Formalism: Newman+08, Menard+13, McQuinn+13

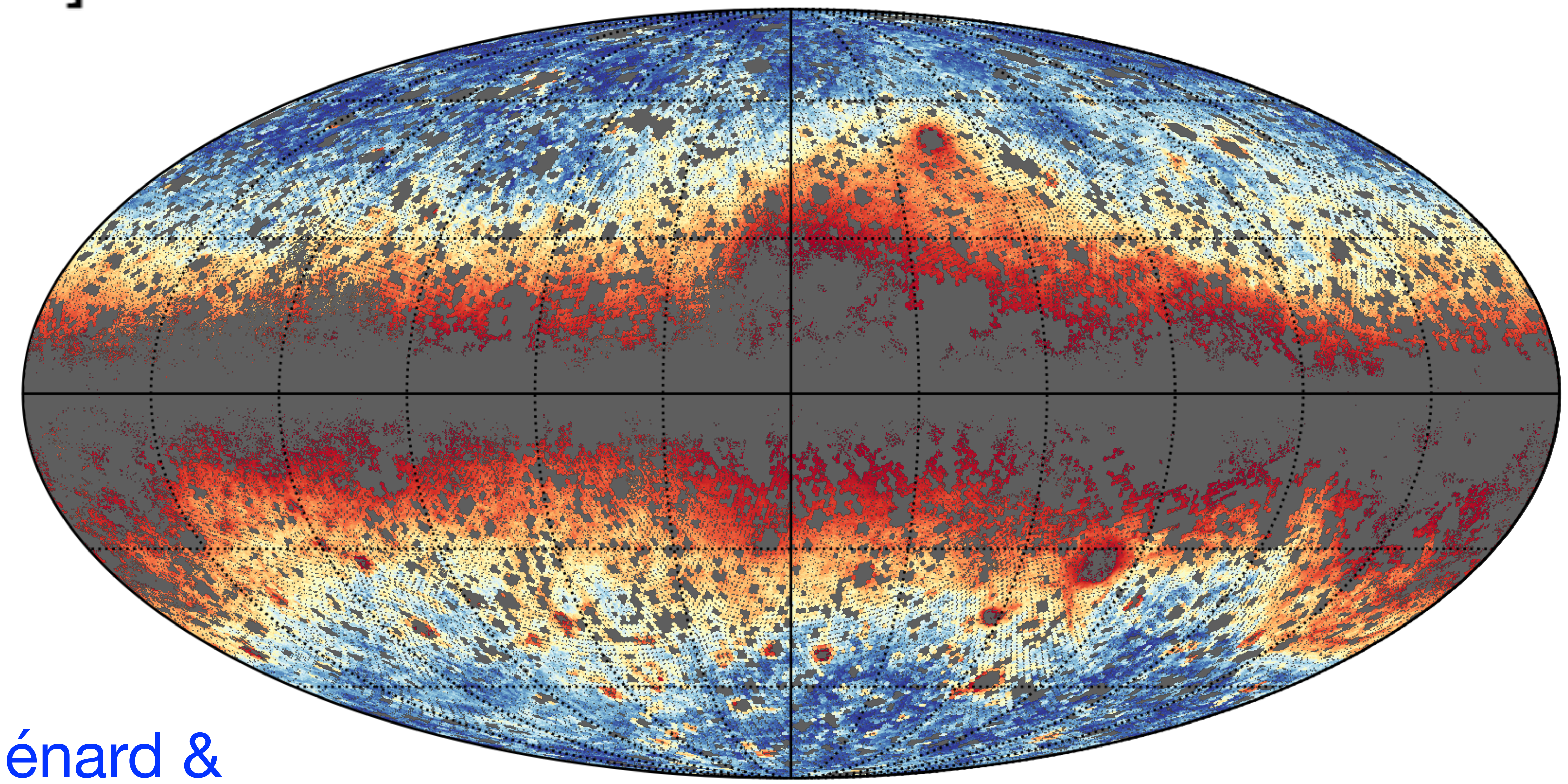
Applications in galaxy surveys: Rahman+16 (SDSS), Scottez+16 (CFHTLS), Morrison+16 (KiDS), Davis+18 (DES)

Cosmic UV background tomography





Far-UV (FUV) 1500 Å

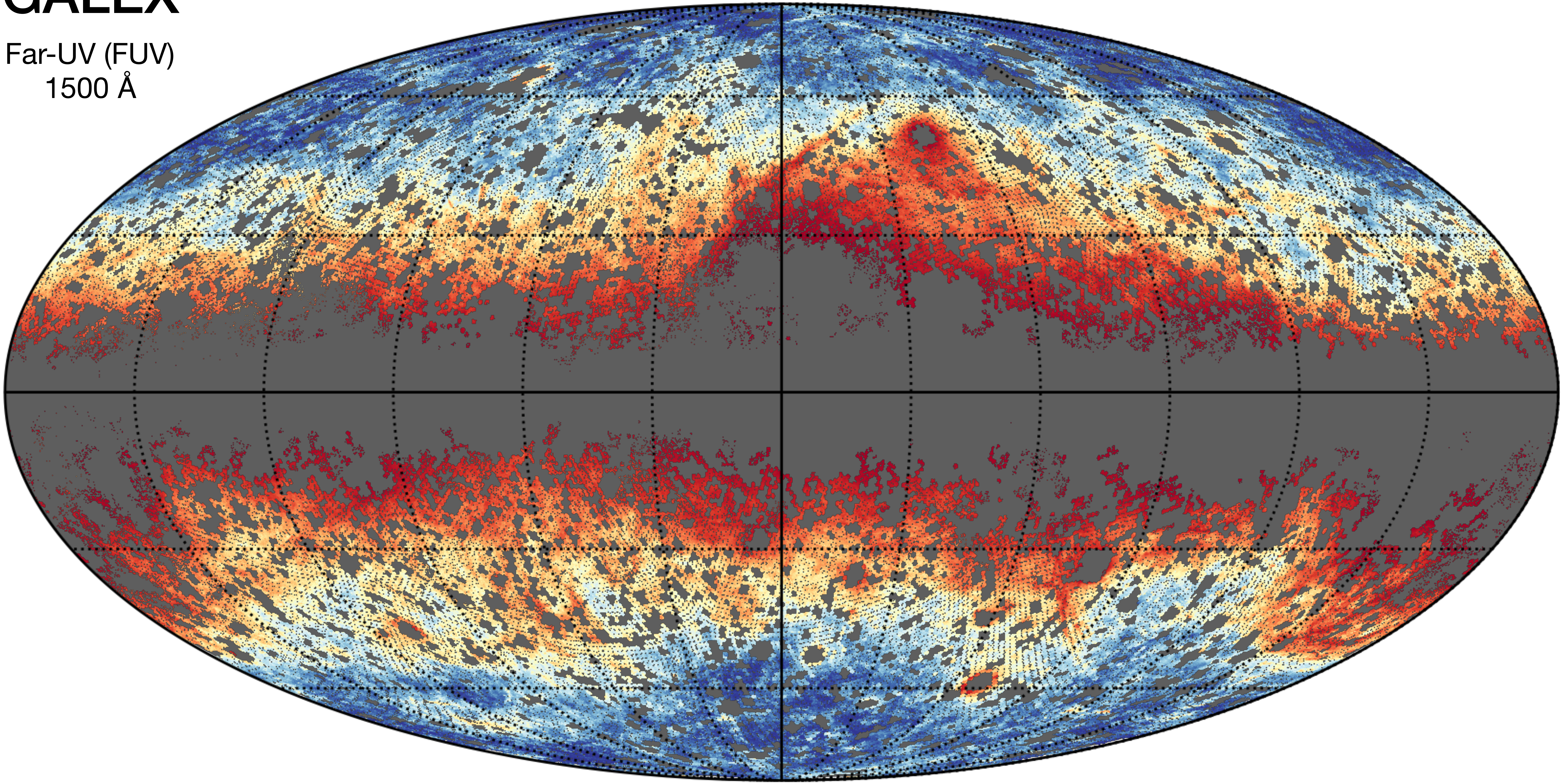


Near-UV (NUV) 2300 Å

Chiang, Ménard & Schiminovich 2019

GALEX

Far-UV (FUV)
1500 Å



GALEX

Far-UV (FUV)
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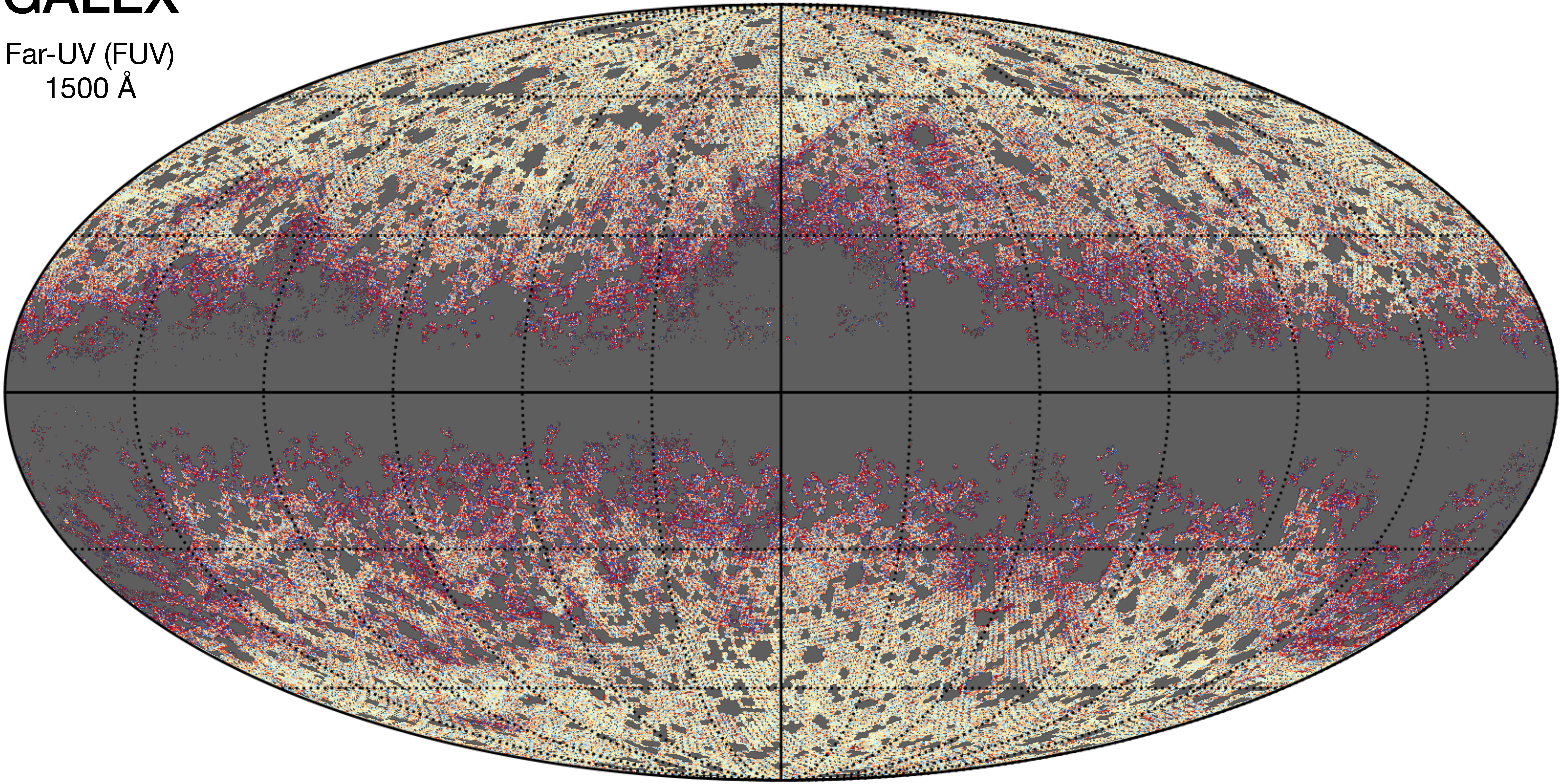
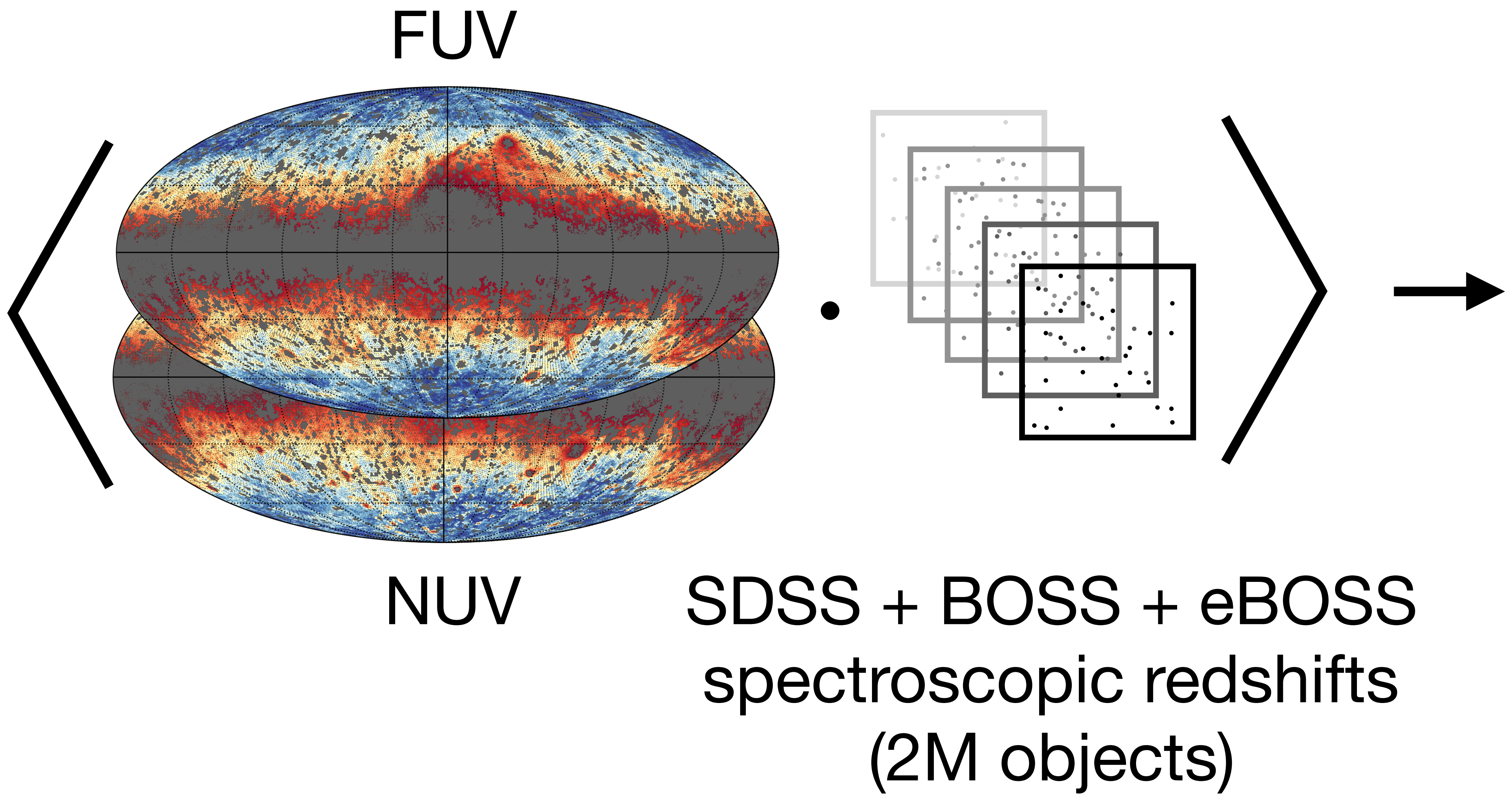
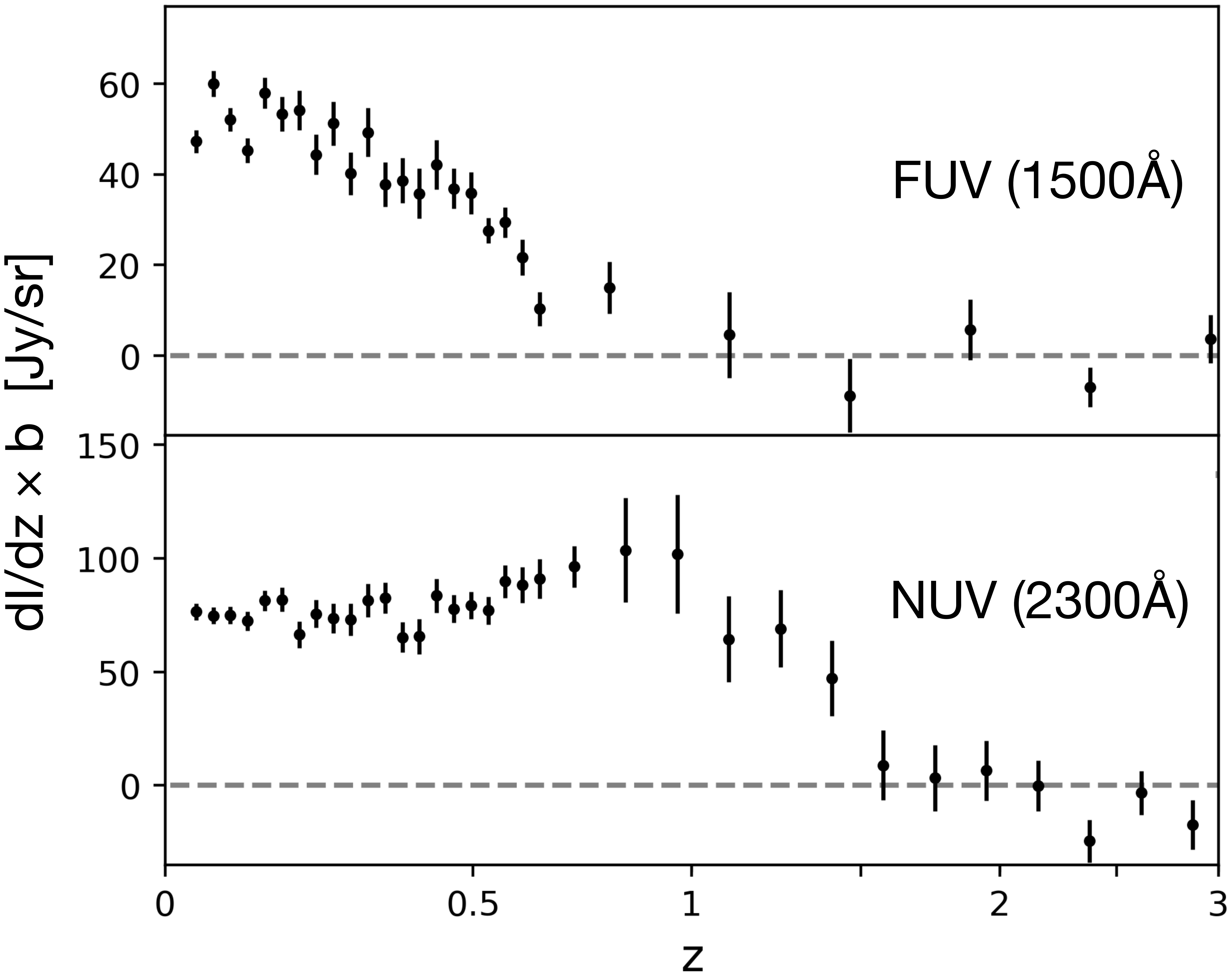



GALEX
Far-UV (FUV)
1500 Å
10 deg scale

Redshift tomography for the Cosmic UV background



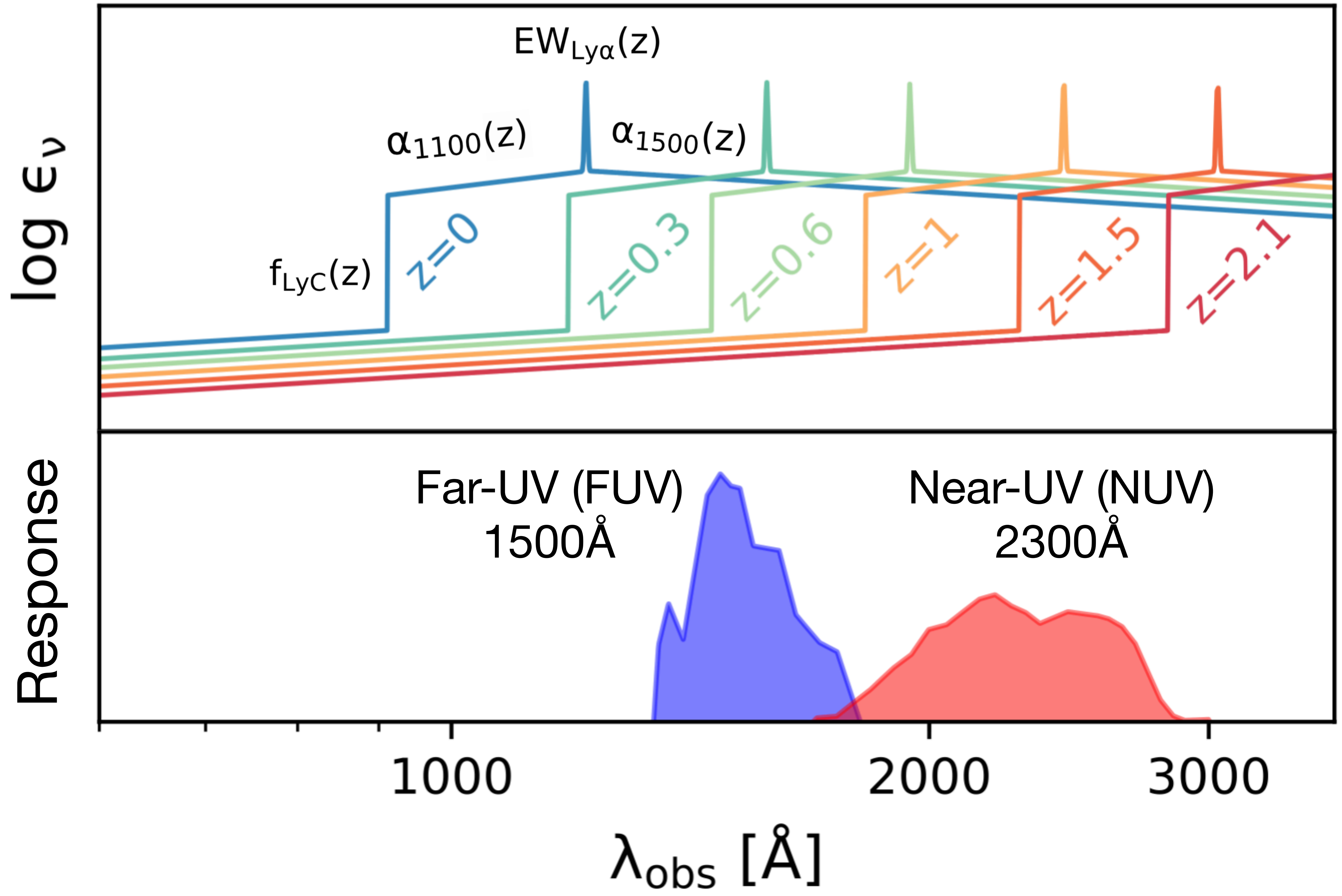
Chiang+ 2019



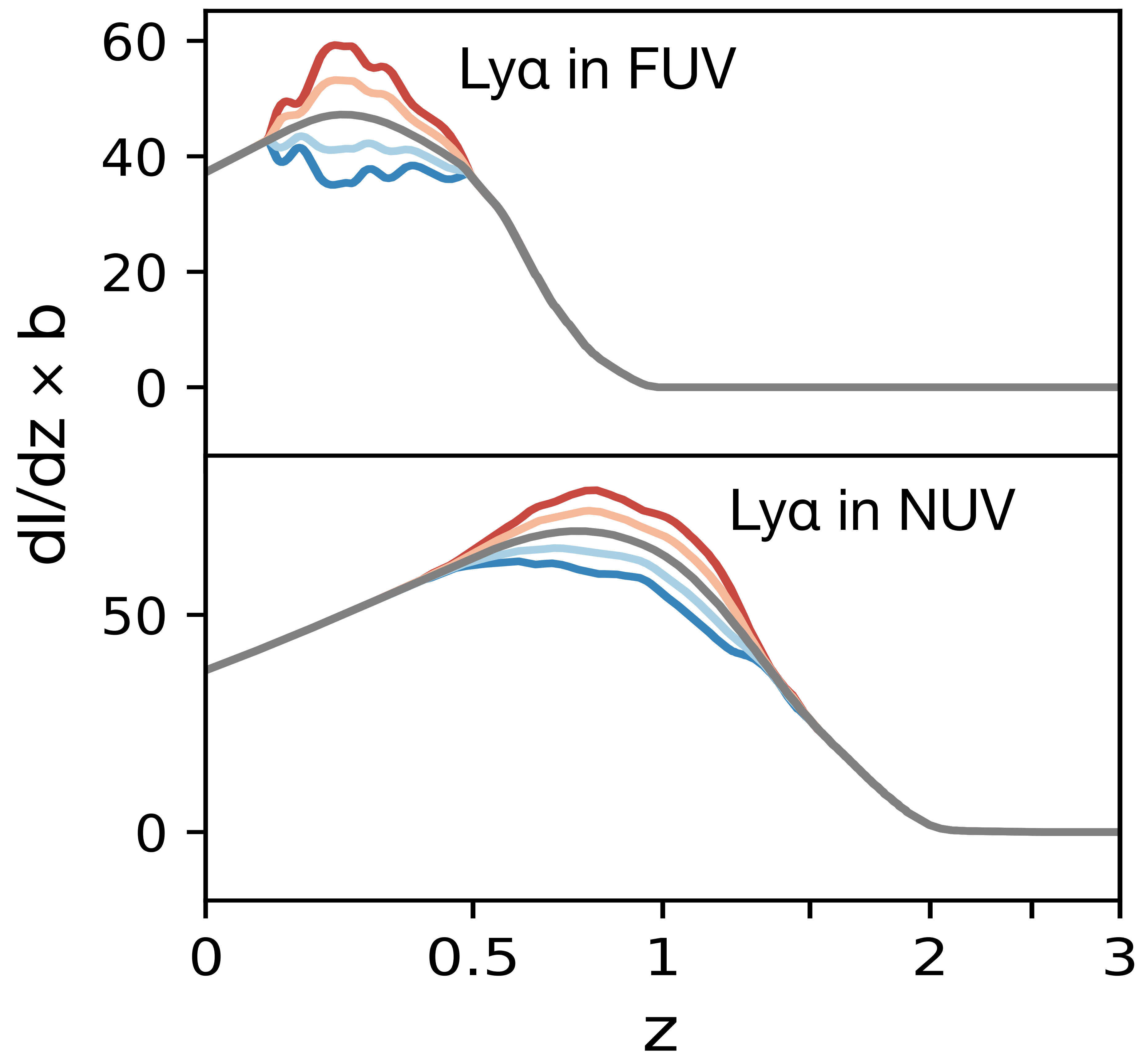
Redshift tomography is simultaneously a frequency tomography

Chiang+ 2019

UV background spectrum



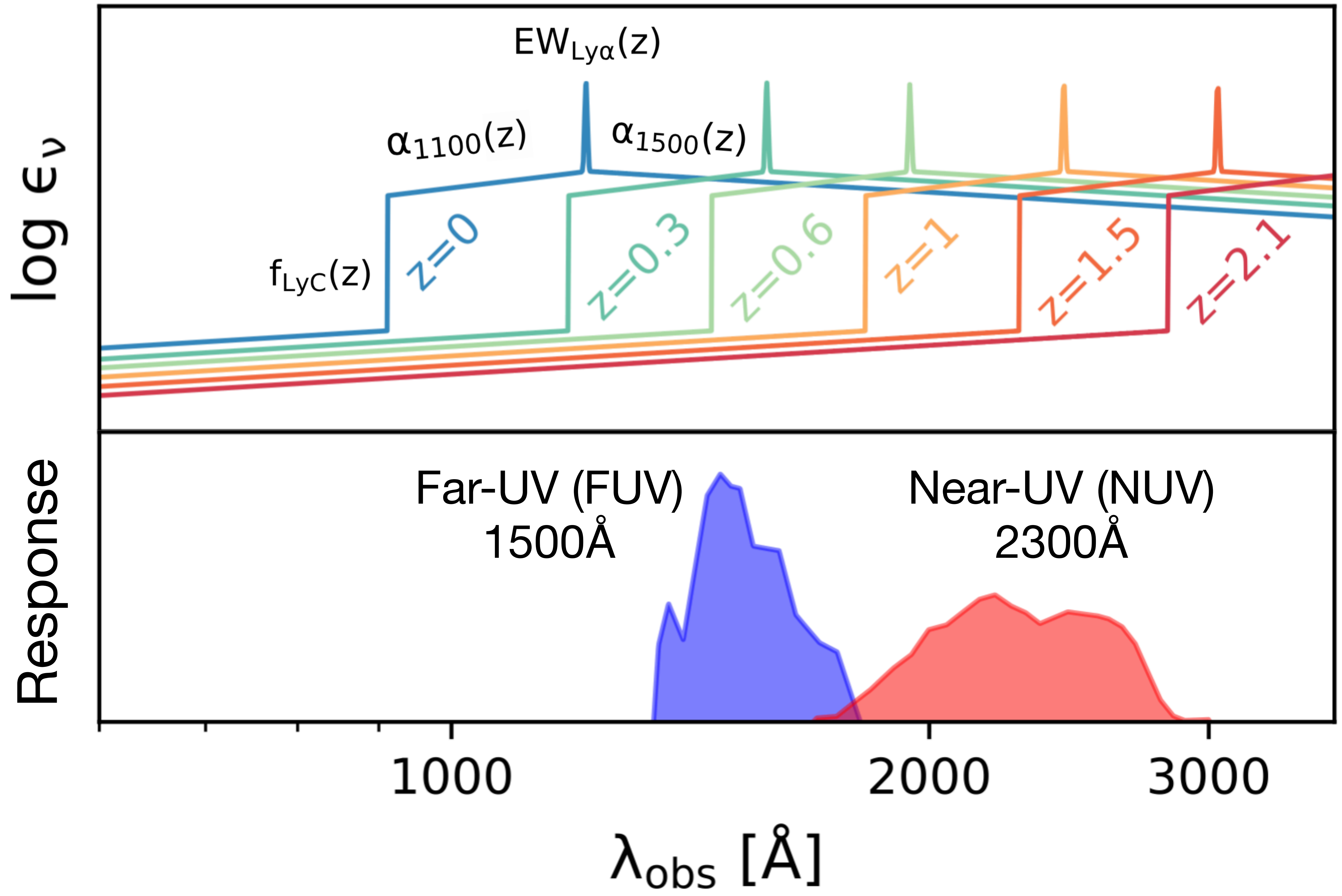
tomographic observable



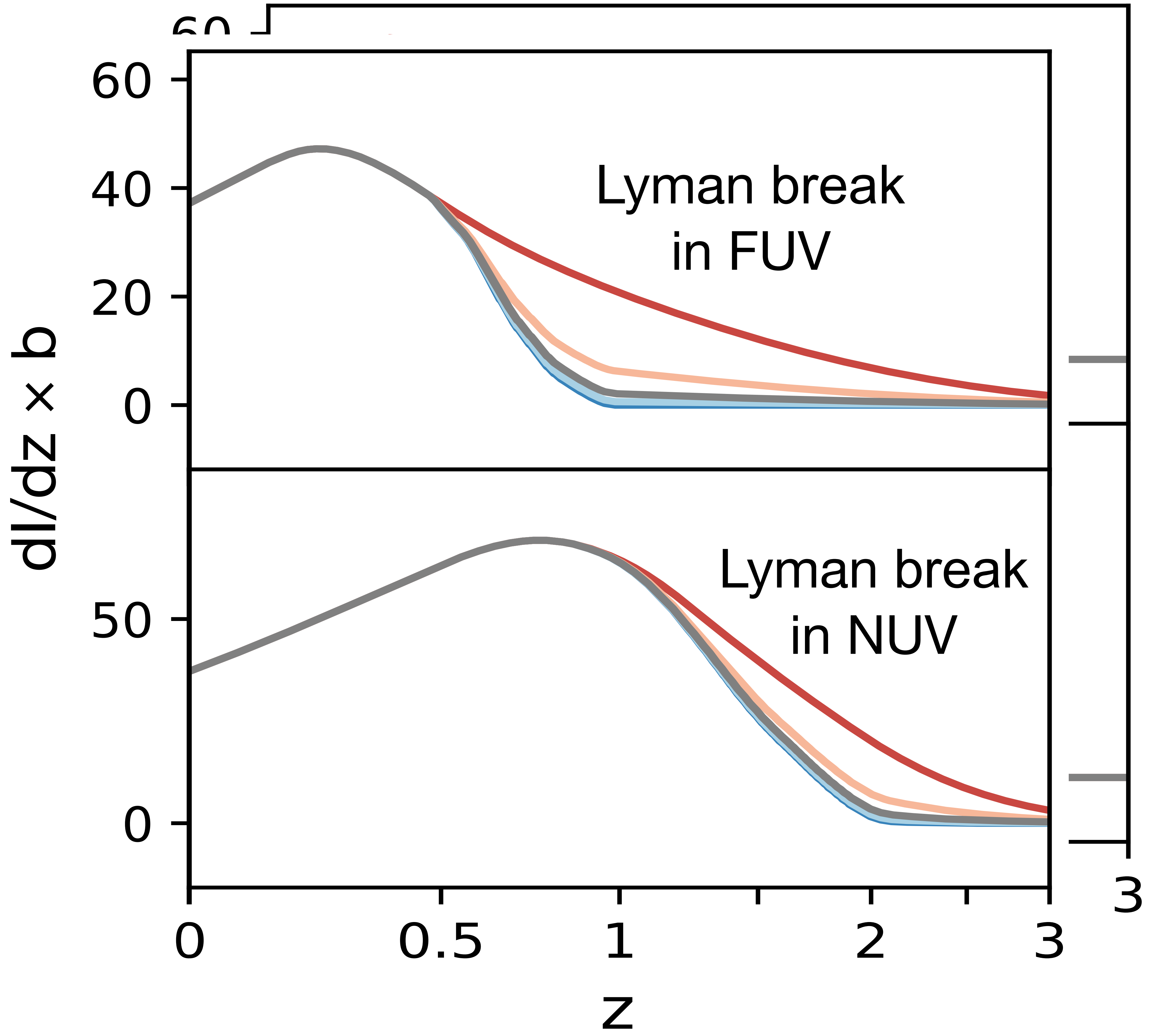
Redshift tomography is simultaneously a frequency tomography

Chiang+ 2019

UV background spectrum



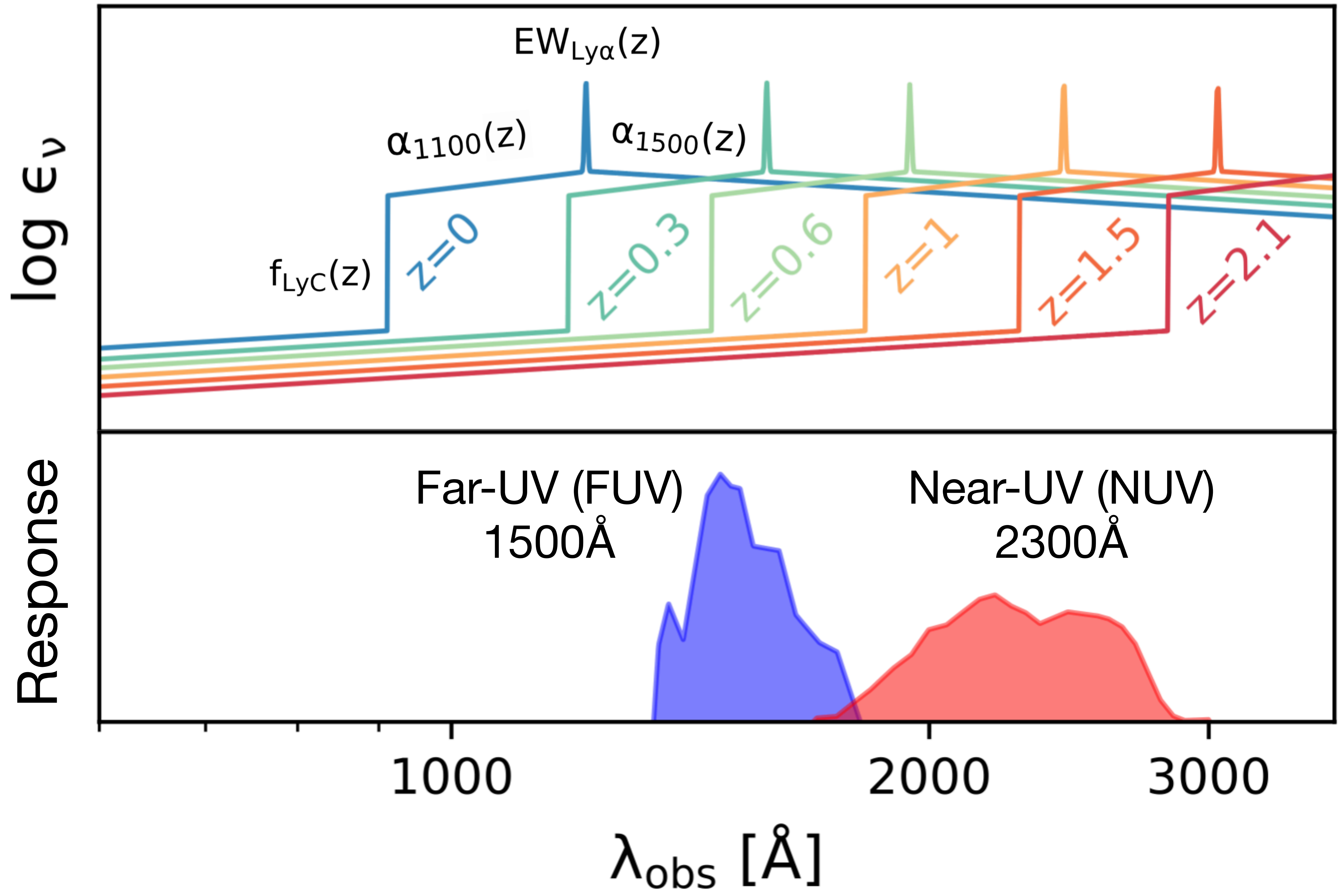
tomographic observable



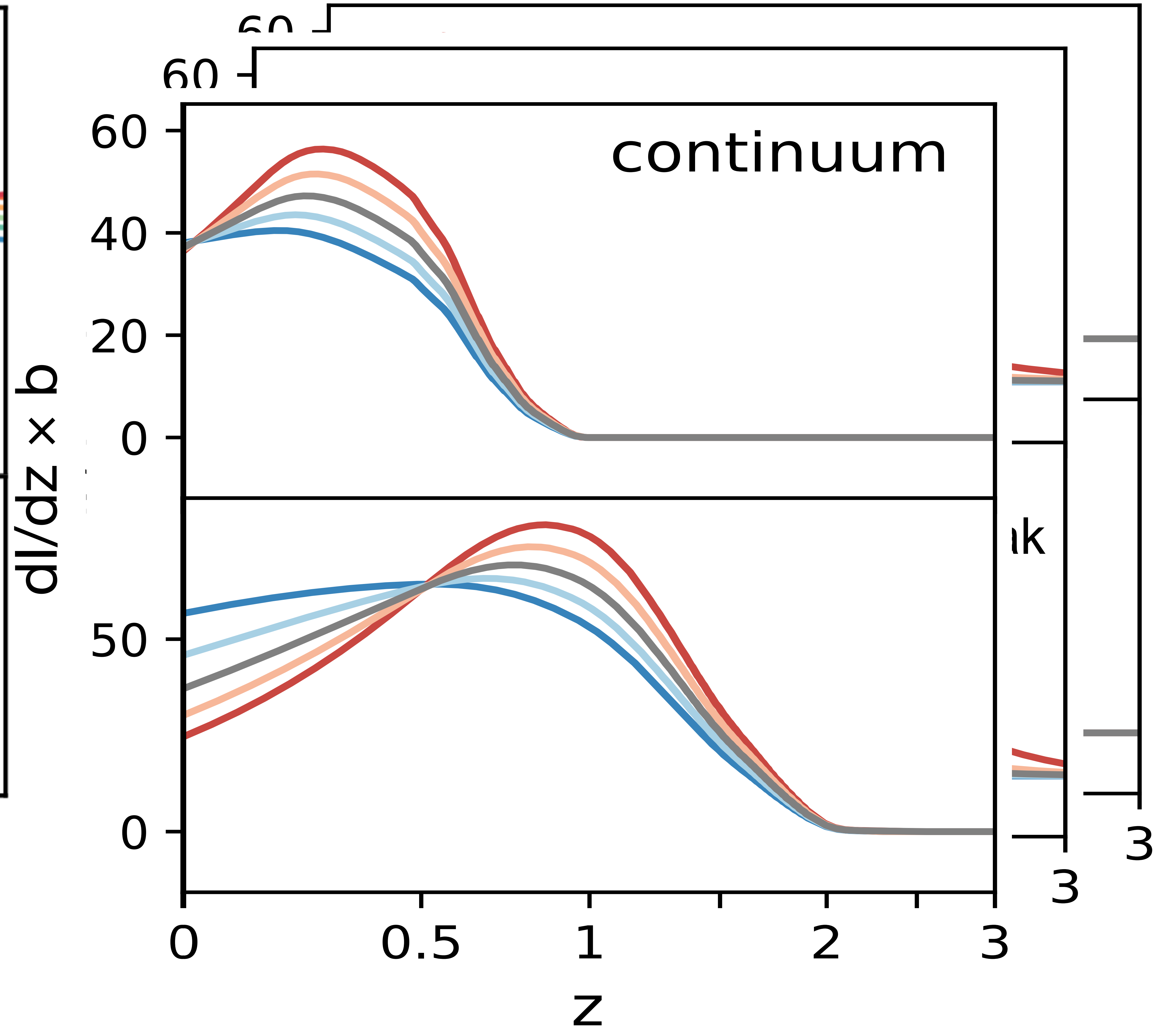
Redshift tomography is simultaneously a frequency tomography

Chiang+ 2019

UV background spectrum

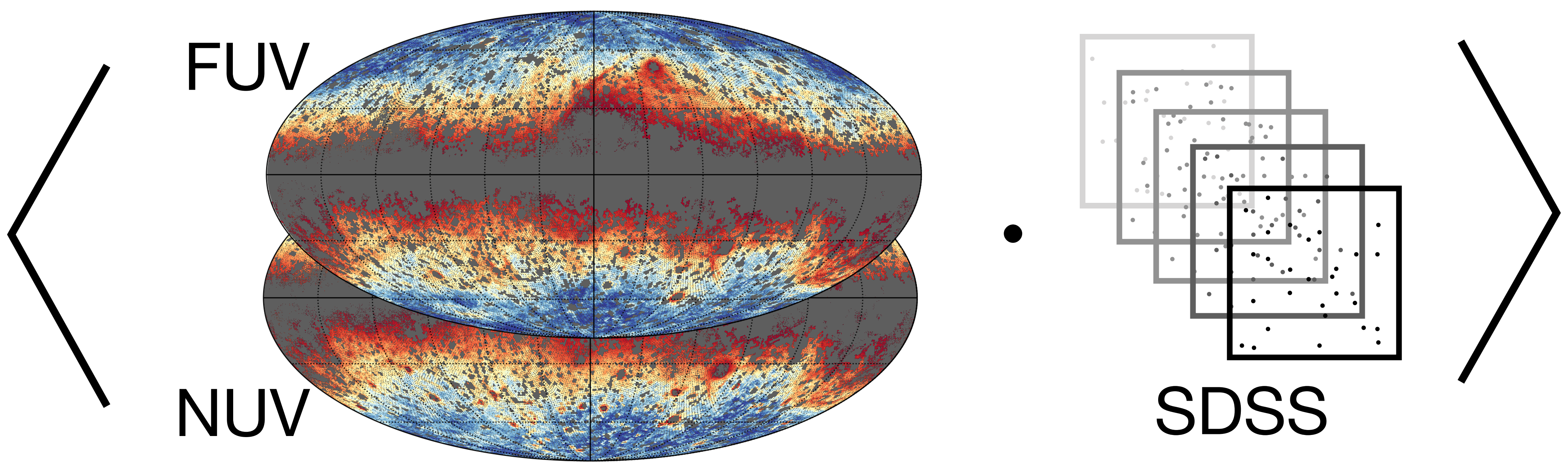


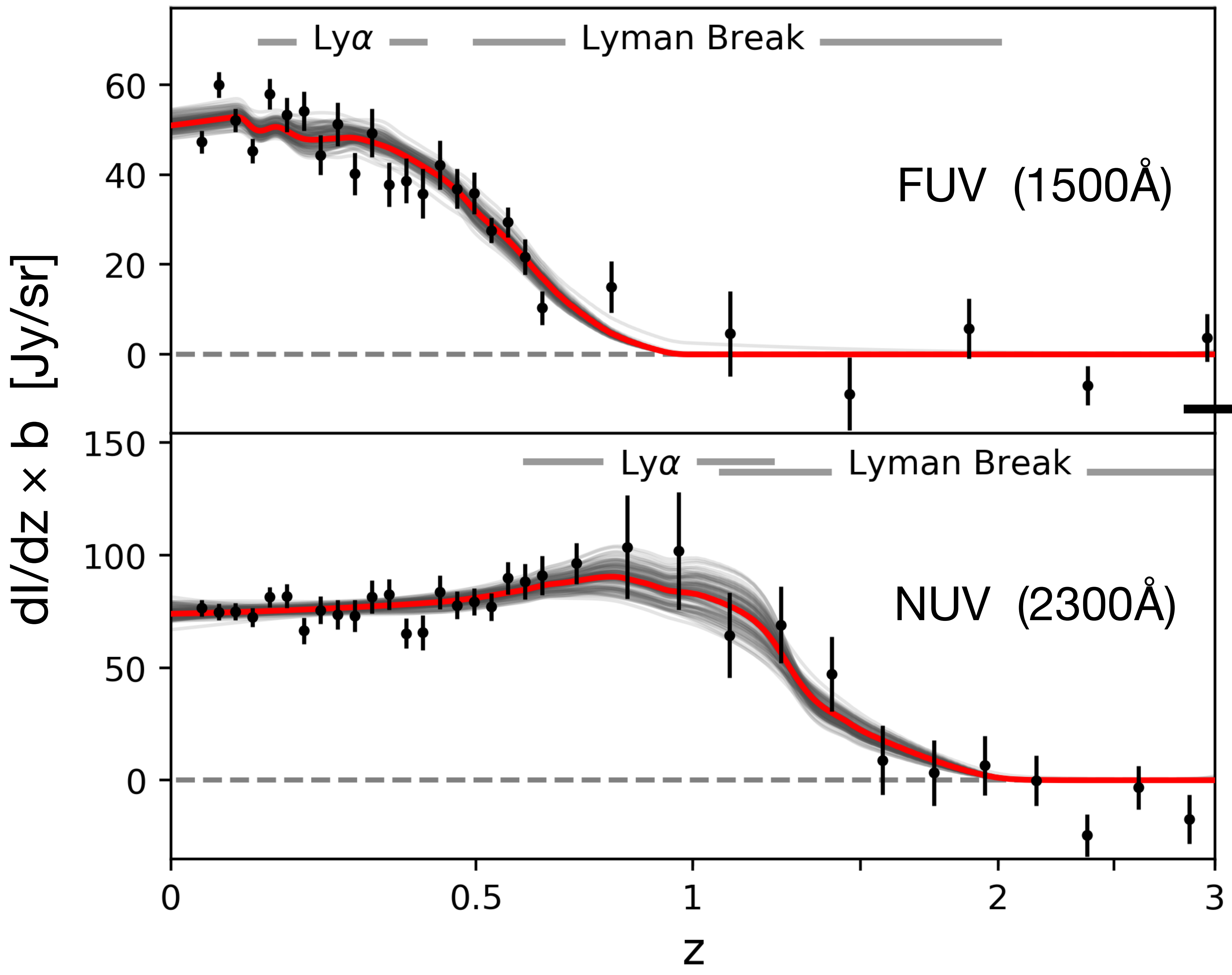
tomographic observable

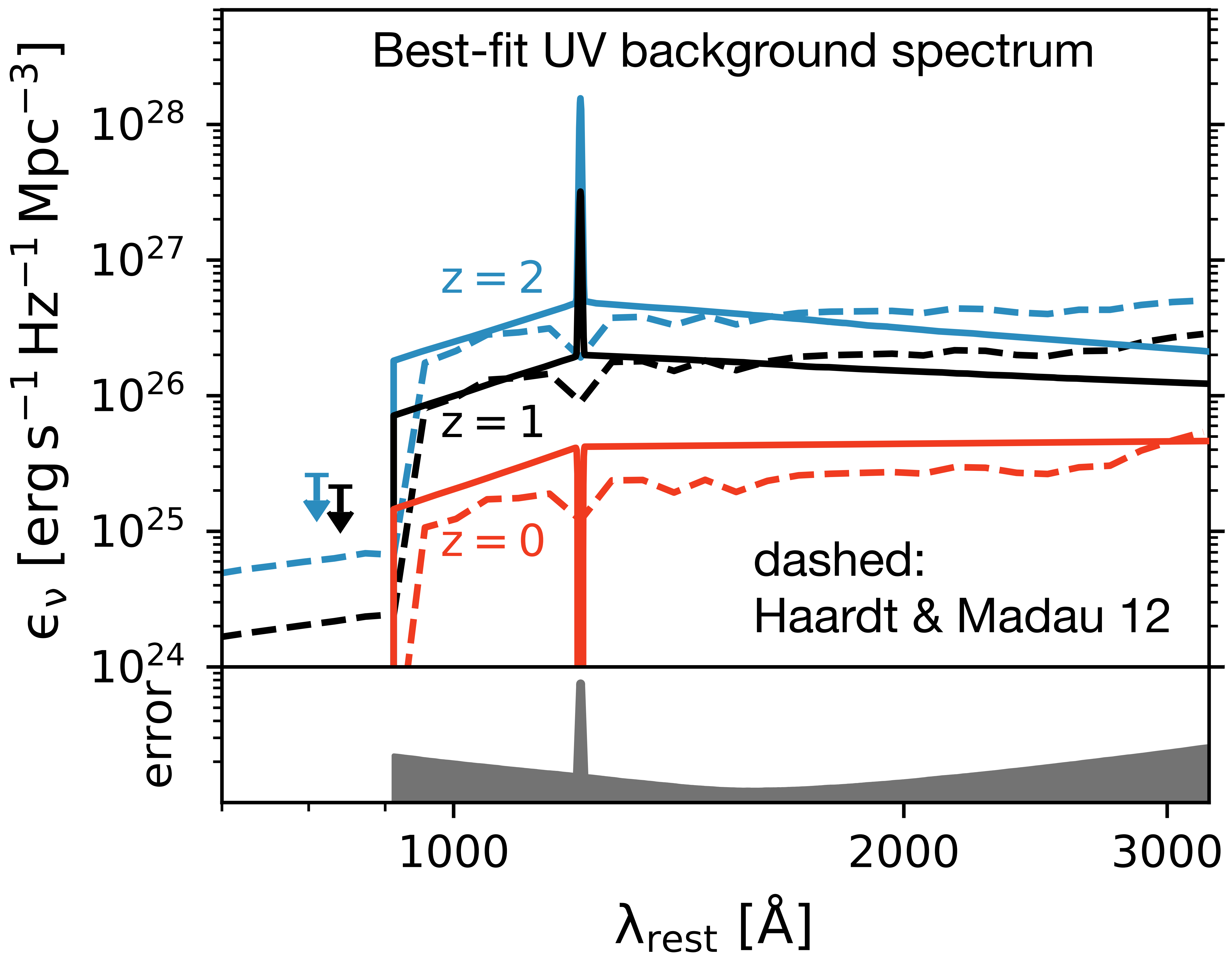


Constraining the UV background spectrum

Chiang+ 2019

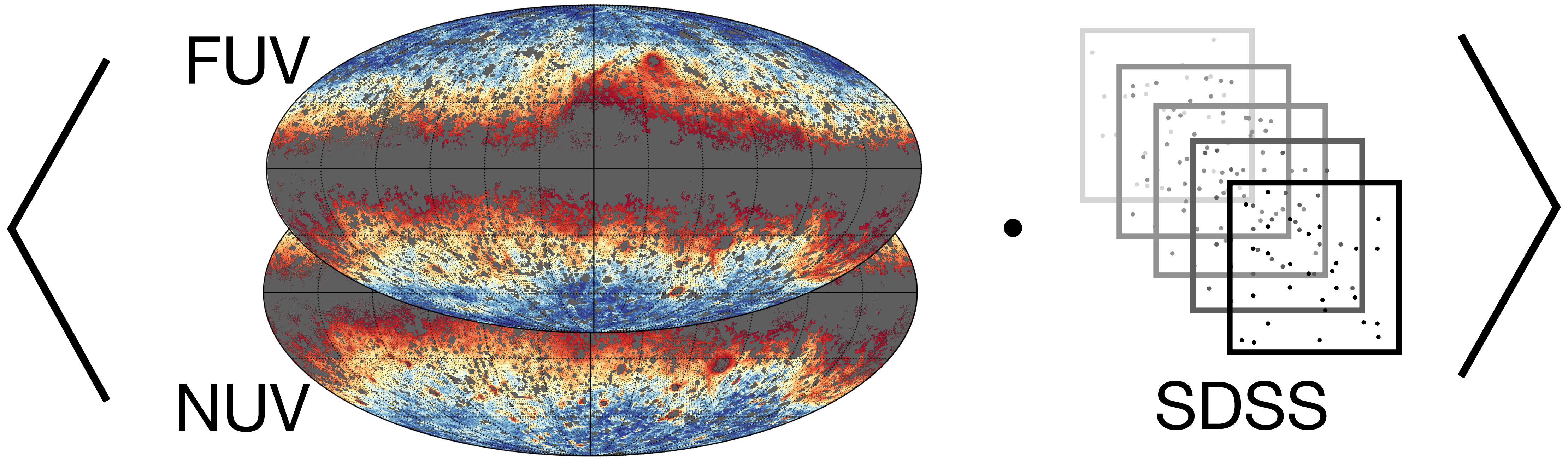


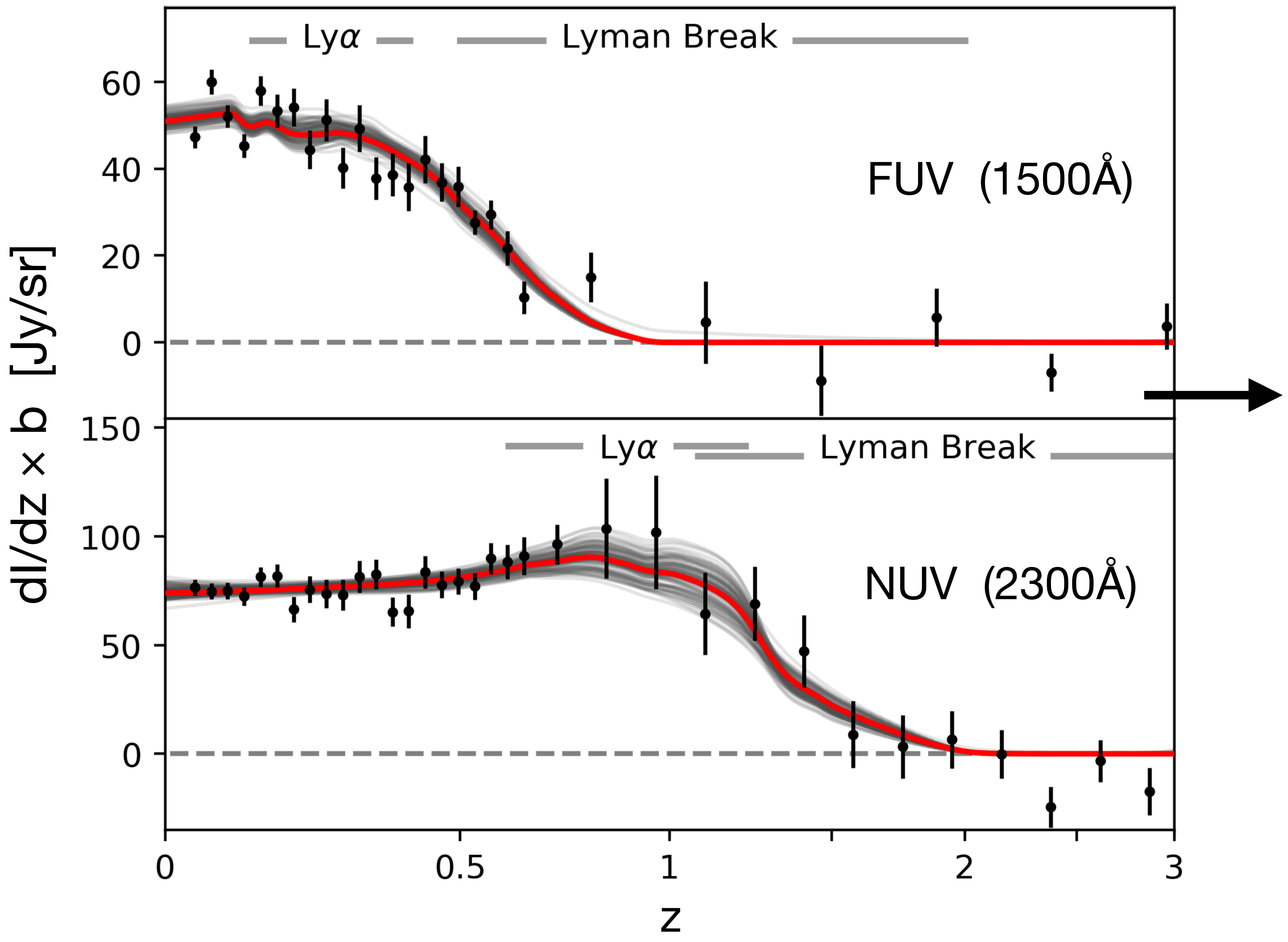




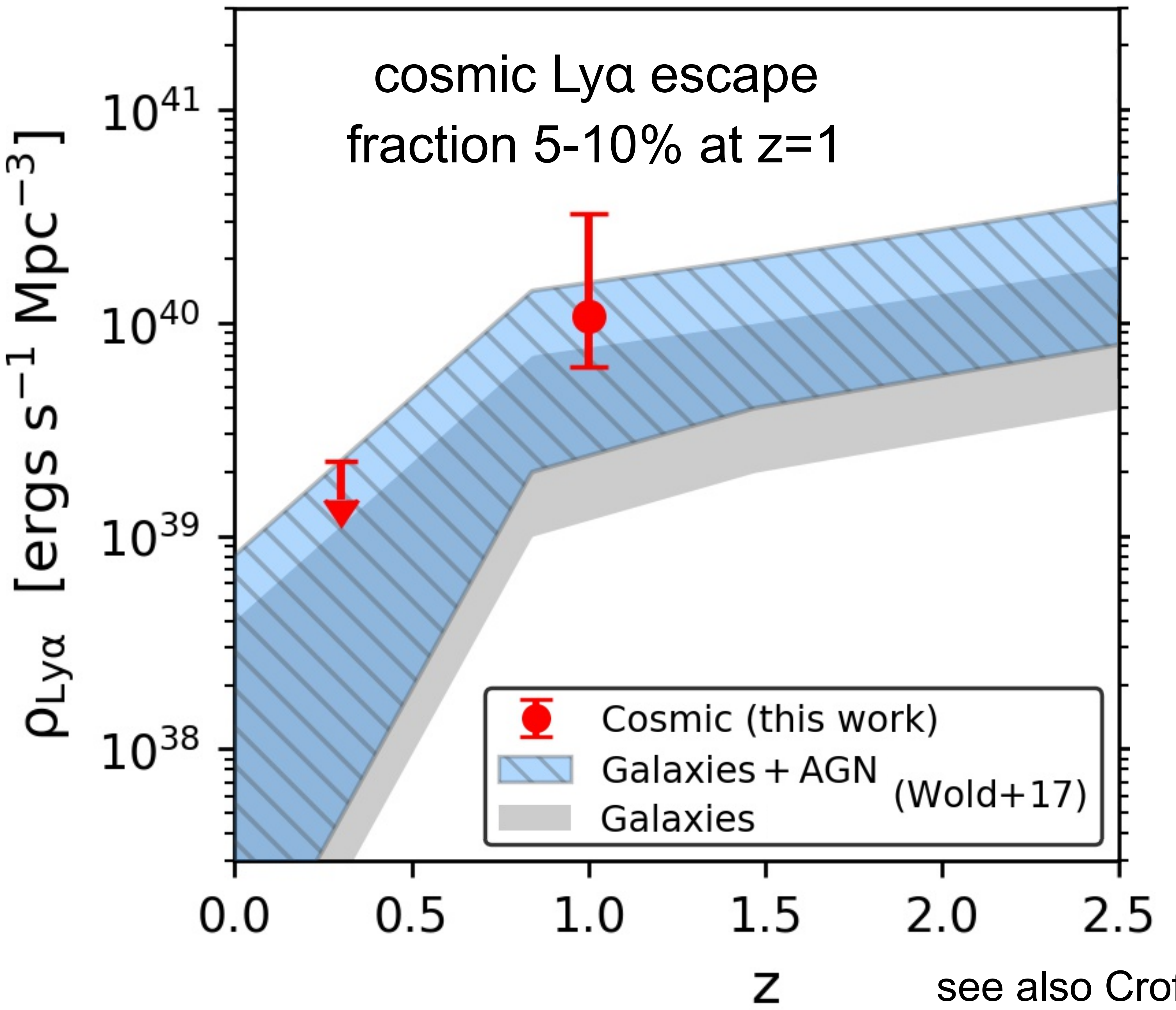
Constraining the UV background spectrum

Chiang+ 2019



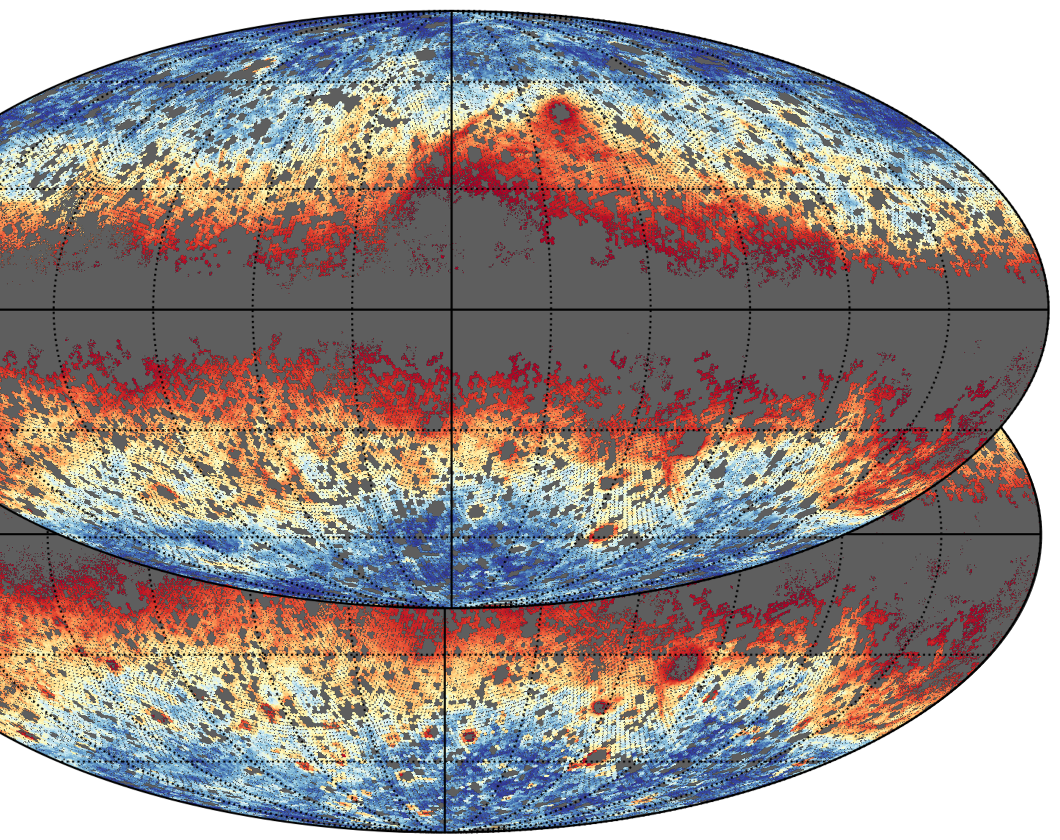


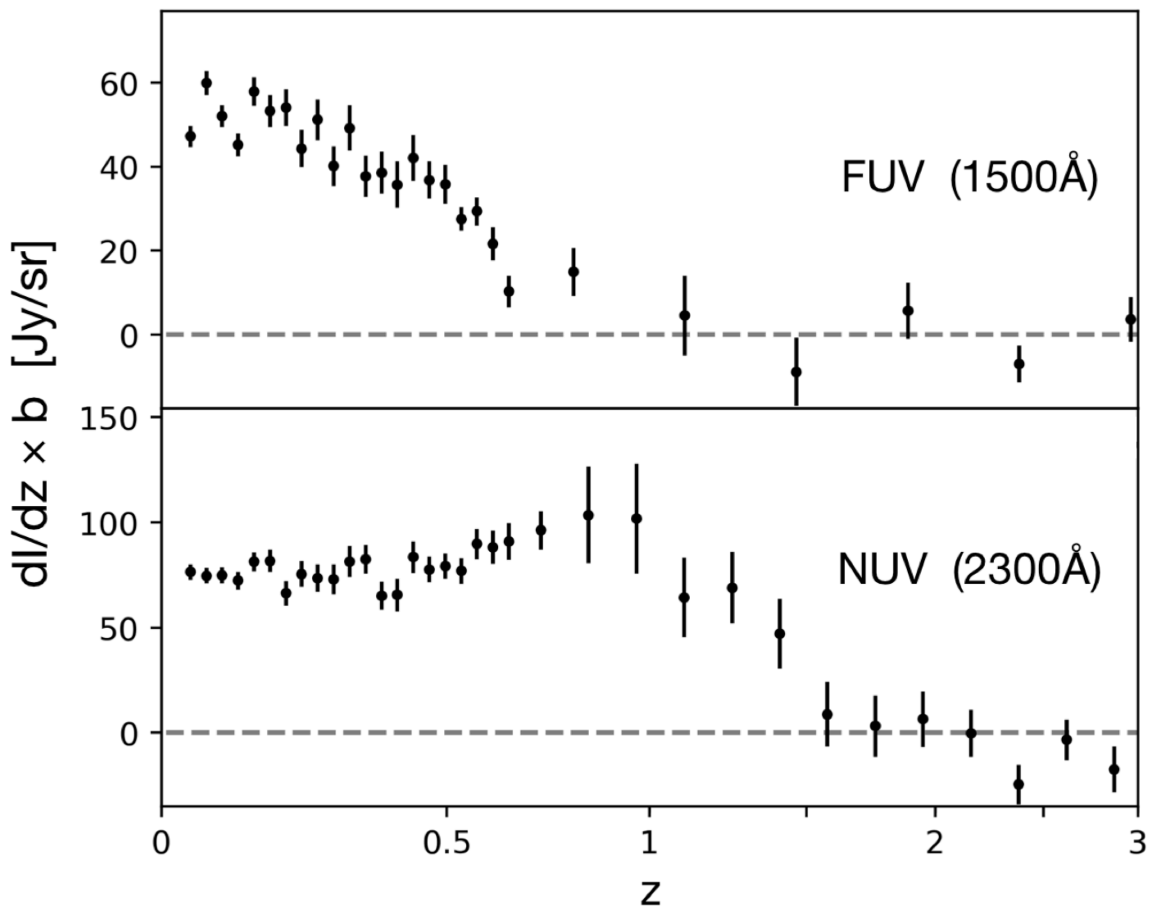
Lyα luminosity density constraints

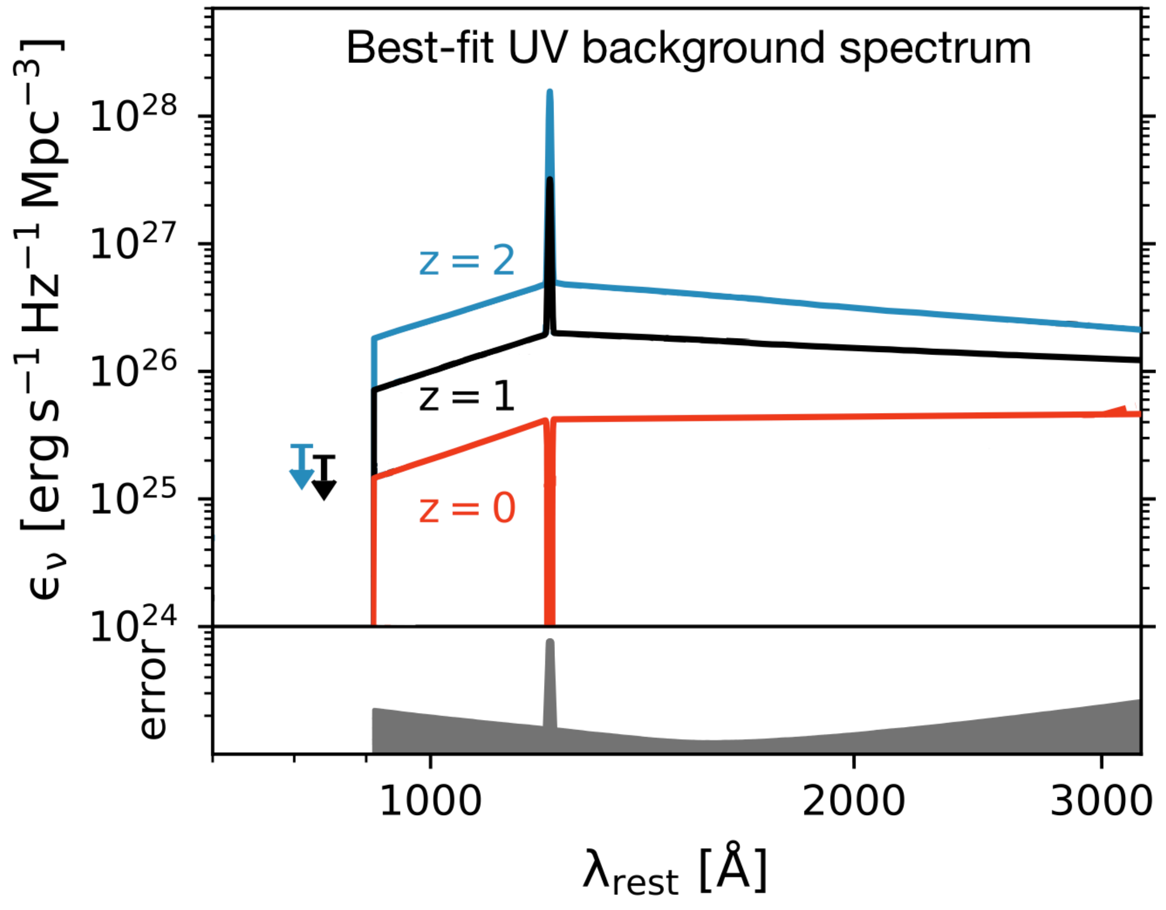


see also Croft+18

The flow of information content







- Cosmic star-formation
- Leakage of Ionizing photons
- Lyα escape from the ISM

spatial fluctuations → redshift → spectra → physics

step 1 (spatial fluctuations → redshift)

step 2 (redshift → spectra)

All is done without using any spectroscopic IM data in the UV

Only 30% of GALEX photons are in detected sources; we have recycled the rest 70%

Multiwavelength view of the diffuse sky

Take-away messages

- GALEX redshift+spectral tomography constrains the full UV background spectrum at z<2
- Clustering redshift analysis could be an integrated part of many experiments, including CMB, HI 21cm, CII, CO, and Lyα intensity mapping to:
    1. test if the foreground maps are free of extragalactic contamination
    2. get p(z) of the extragalactic light