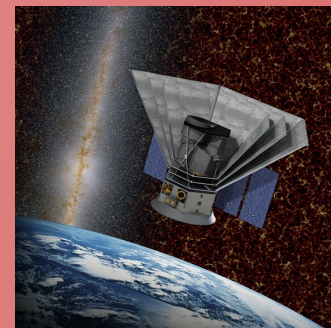
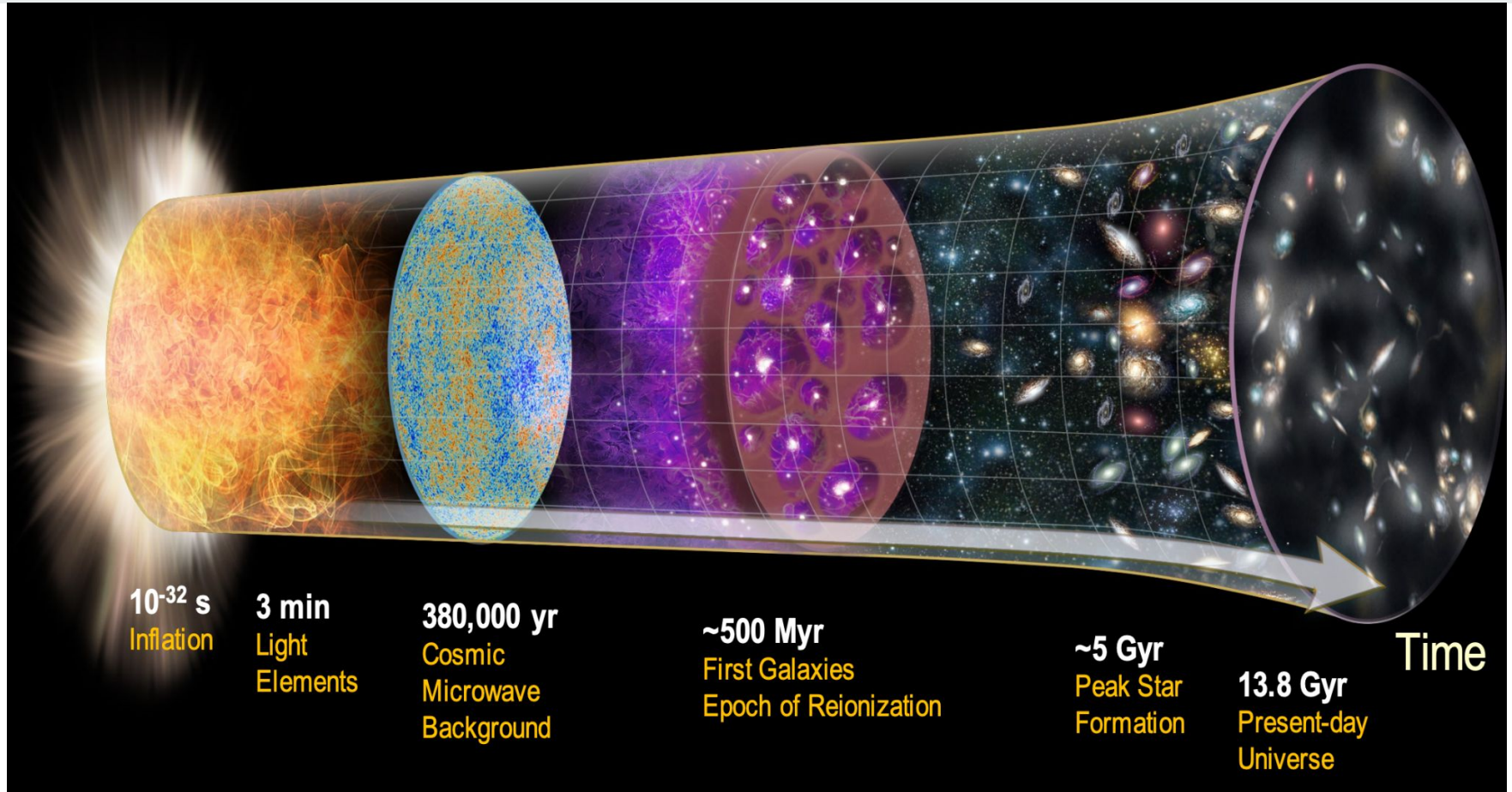


Uncovering the near-infrared universe through galaxy surveys and intensity mapping

Richard Feder, on behalf of *SPHEREx* and *CIBER* collaborations

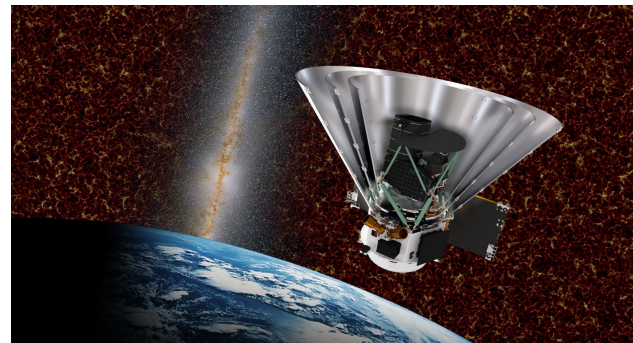




SPHEREx: an all-sky, near infrared spectral survey

- NASA's next MIDEX mission with launch date in early 2025
- Small aperture (20cm) telescope designed for high mapping speed
- SPHEREx will obtain a low-resolution NIR spectrum for each 6.2"x 6.2" line of sight on the sky from 0.75-5 μm
- Legacy data archive will be useful for many applications, but three main science drivers:

Source: Caltech/NASA JPL



How did the Universe begin?



3D galaxy survey probes inflation through measurements of primordial non-Gaussianity

How did Galaxies form?



Cosmic light production studied through NIR fluctuations of the extragalactic background light

What are the conditions for Life to begin?



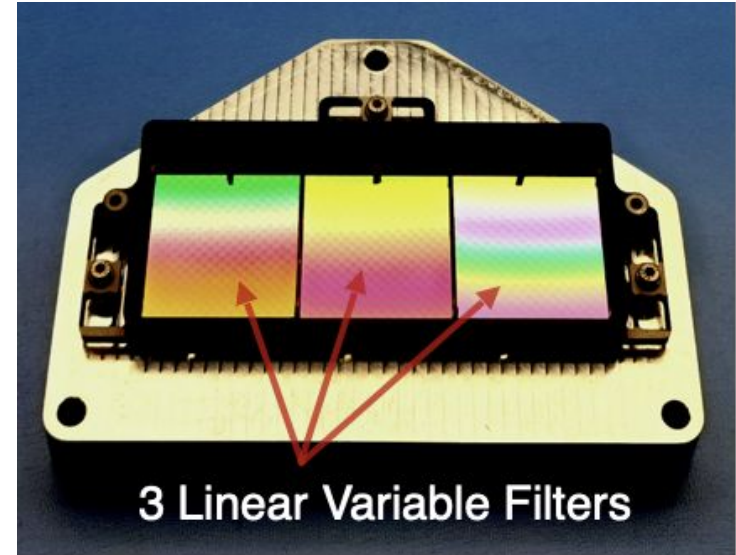
Survey the Milky Way for water and other biogenic ices measured through absorption features

SPHEREx is really happening!



Spectroscopy without a spectrometer

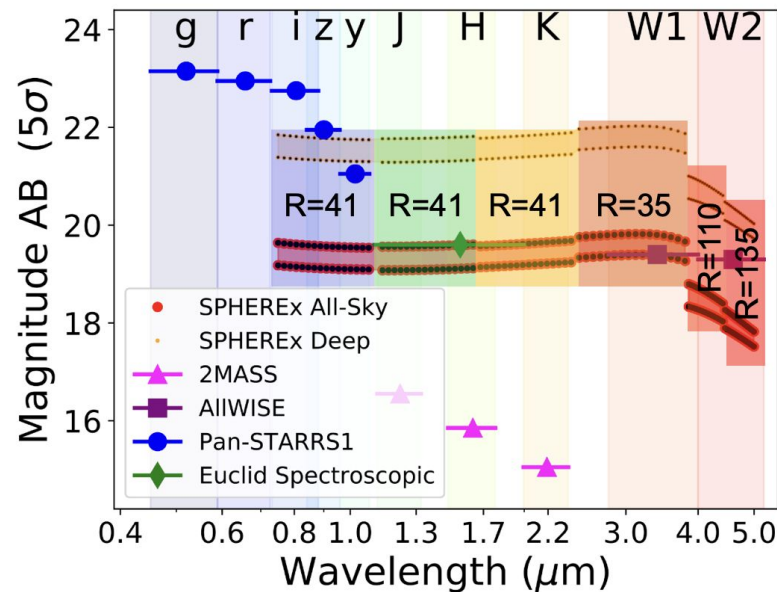
- Six H2RG detectors arranged in two 1x3 mosaics
- Linear Variable Filters (LVFs) placed above each detector
 - bandpass filter with central wavelength that varies with detector coordinate



Source: SPHEREx Collaboration

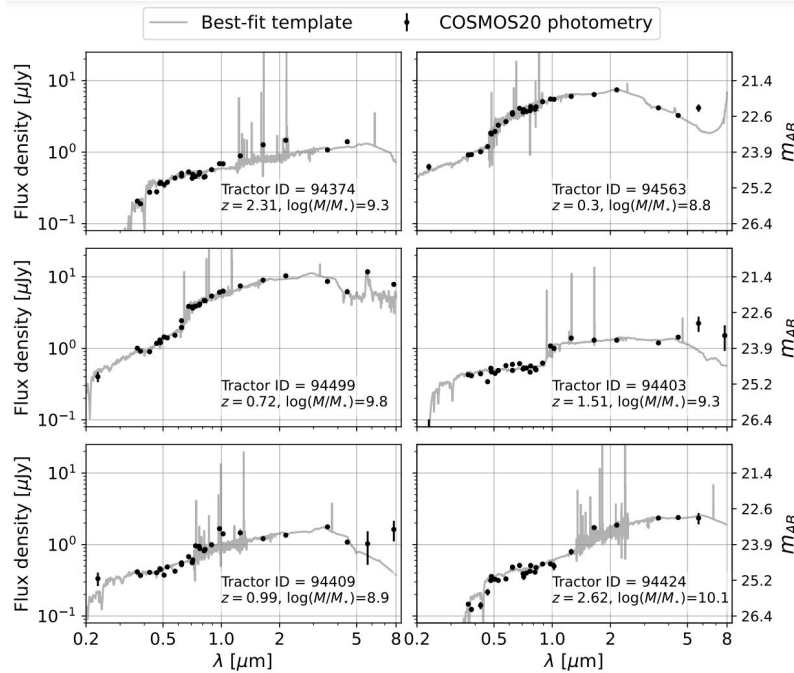
Simulating SPHEREx galaxy spectrophotometry

- Want simulated galaxy spectra with realism and diversity of the SPHEREx sample
 - fit multi-band COSMOS2020 photometry ([Weaver+22](#)) to constrain galaxy continua
- But emission lines unconstrained by COSMOS photometry!
 - Empirical scaling relations to predict line strengths, ratios w.r.t redshift, stellar mass, galaxy type, etc.



Galaxy SED simulation workflow

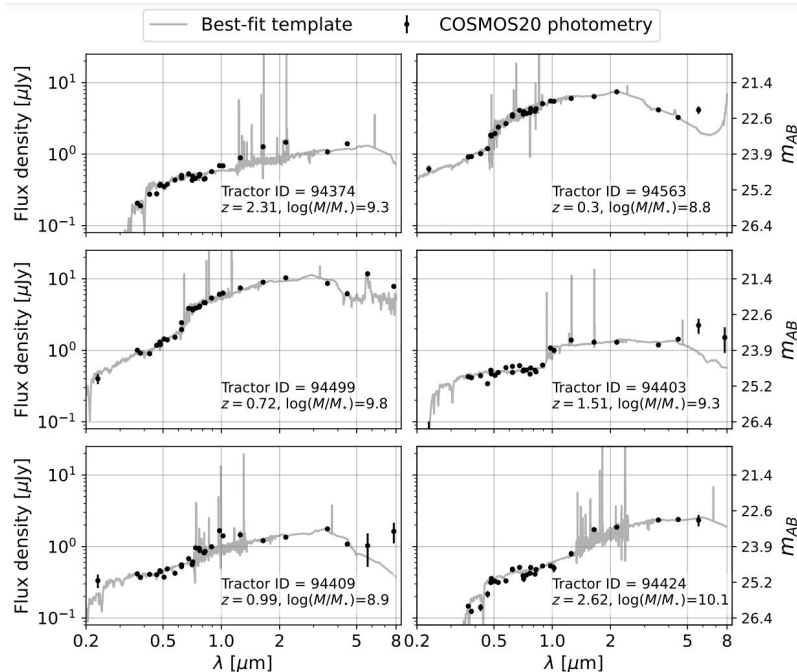
(Feder+2023)



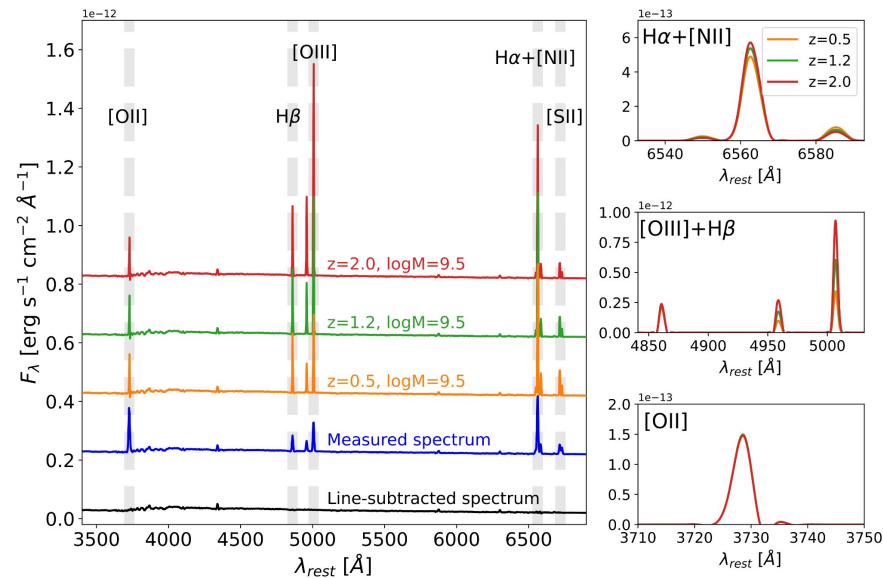
Template fits to broad (+narrow) band photometry give continuum model.

Galaxy SED simulation workflow

(Feder+2023)



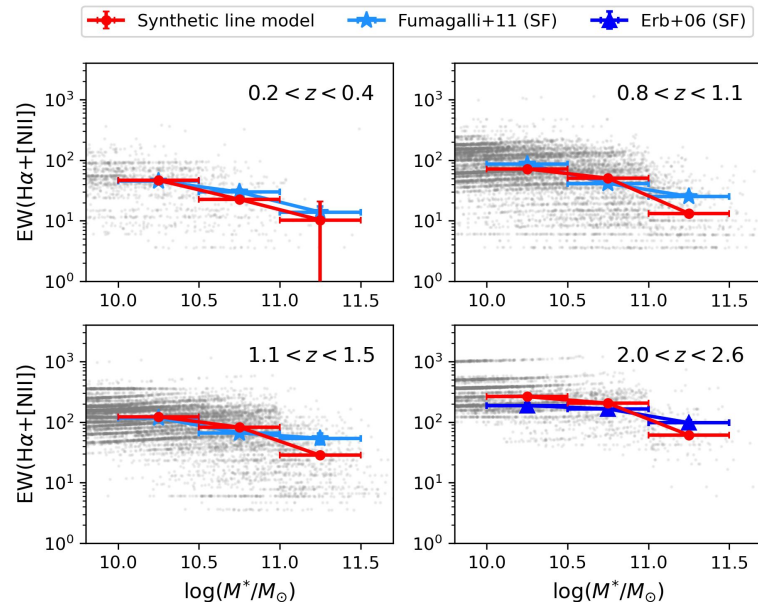
Template fits to broad (+narrow) band photometry give continuum model.



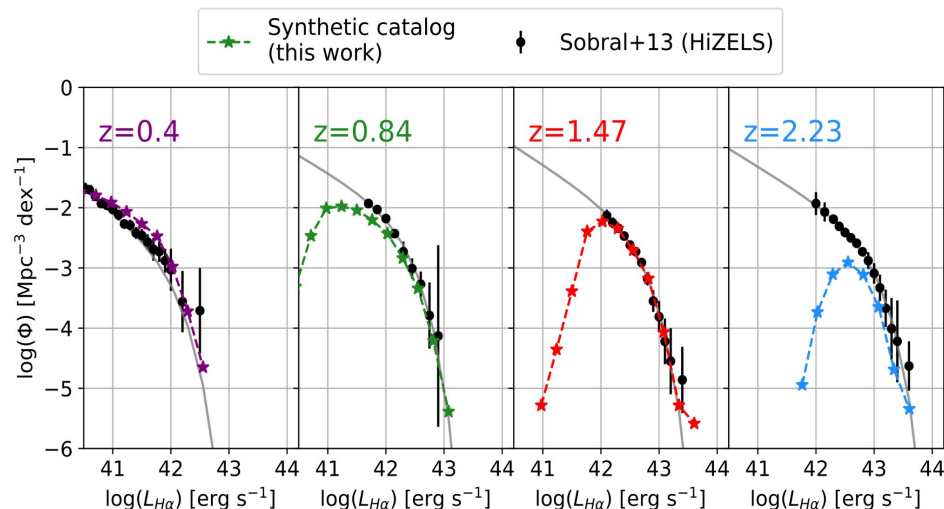
Line strengths/ratios from empirically derived scaling relations w.r.t. redshift, stellar mass, galaxy type, etc.

Line model validation

H α + [NII] equivalent width vs.
stellar mass, redshift



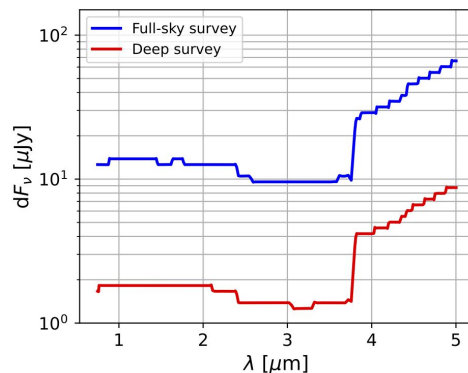
CLIPonSS: Conditional Line Painting on
Synthetic Spectra (Feder+2023)



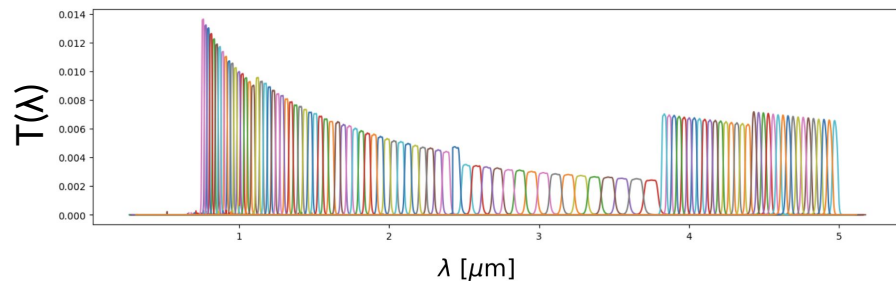
Model also validated for [OII] and [OIII] + novel
predictions for Paschen-alpha (1.87 μ m)

Simulating SPHEREx spectrophotometry

SPHEREx MEV 1σ
point source
sensitivity
estimates, assuming
mean Zodiacal light
level, uniform depth



Measured SPHEREx transmission curves for 102 channels

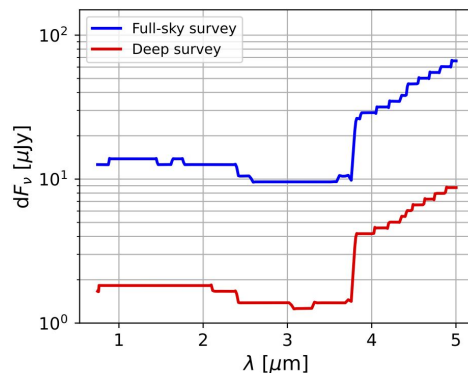




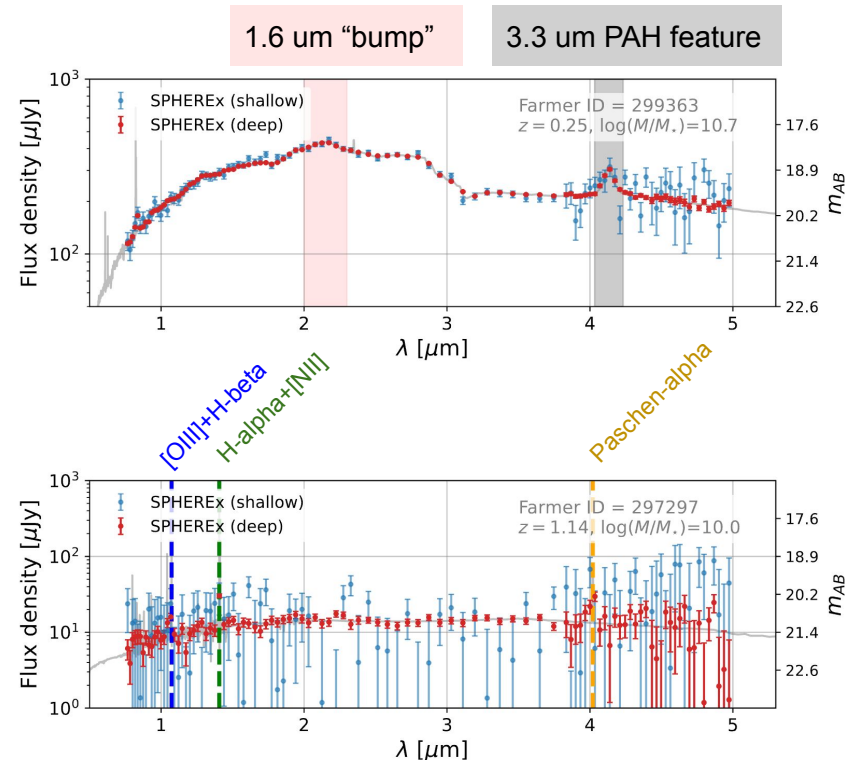
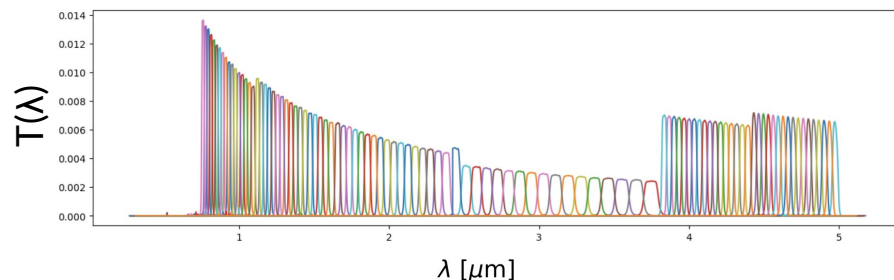
Simulating SPHEREx spectrophotometry

(Feder+2023)

SPHEREx MEV 1σ
point source
sensitivity
estimates, assuming
mean Zodiacal light
level, uniform depth



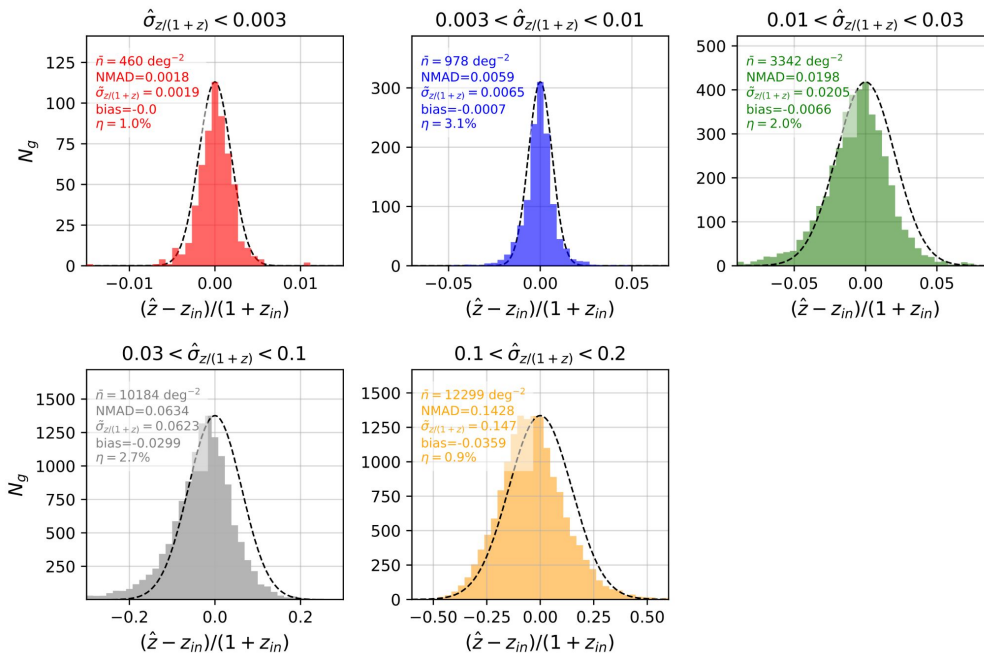
Measured SPHEREx transmission curves for 102 channels



Continuum redshift estimation

(Feder+2023)

- Template fitting photo-z code from [Stickley+16](#) tested on synthetic observations
 - 102-band SPHEREx + DECaLS (g, r, z) + WISE (W1, W2)
- COSMOS + GAMA bright sample → redshift forecasts over “full sky” (fsky=0.75, 30000 deg²)
 - 19M with $dz/1+z < 0.003$
 - 445M with $dz/1+z < 0.1$
 - 810M with $dz/1+z < 0.2$

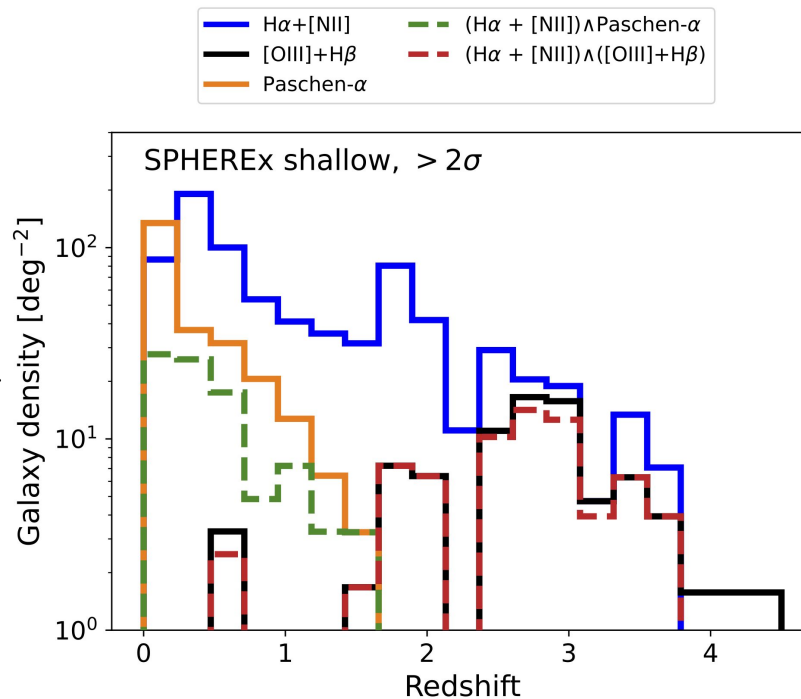
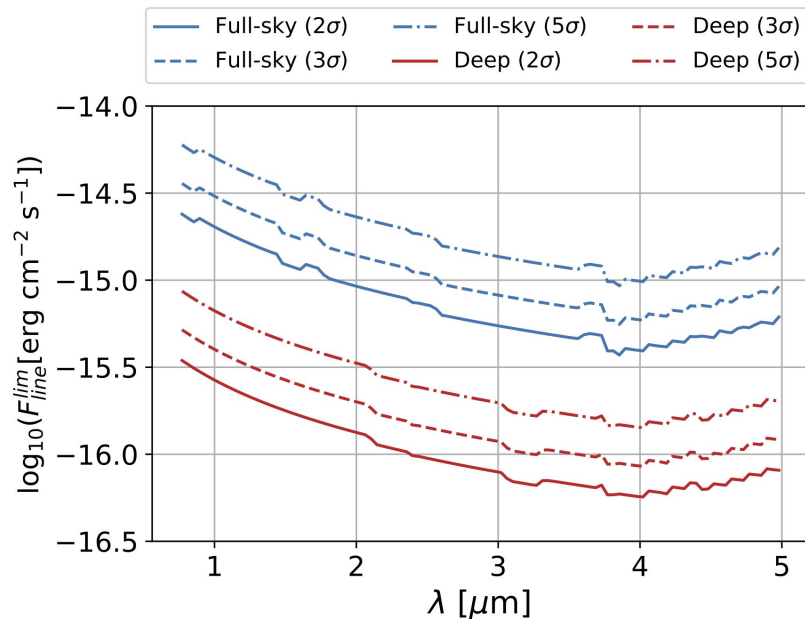


Redshift recovery for COSMOS2020 sample ($i > 18$)

Forecasting the prevalence of emission lines for SPHEREx

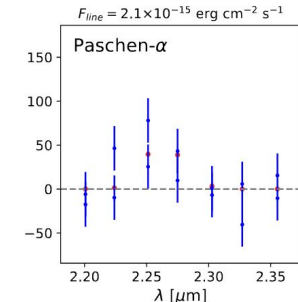
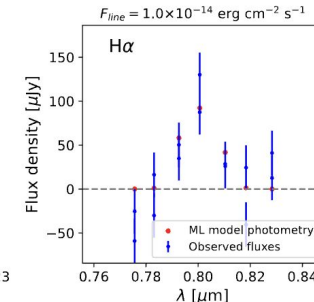
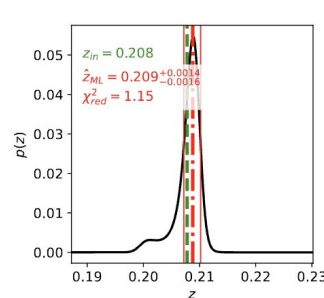
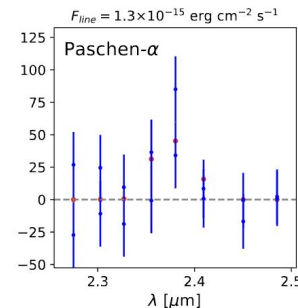
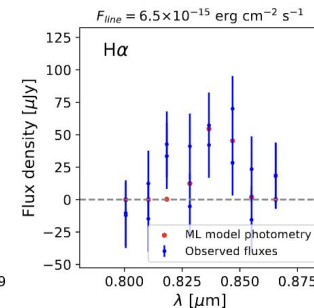
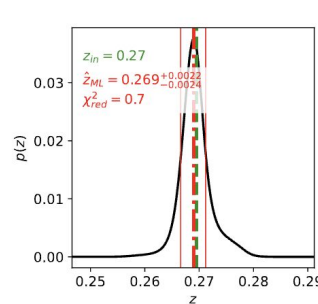
(Feder+2023)

Line flux sensitivity vs. wavelength



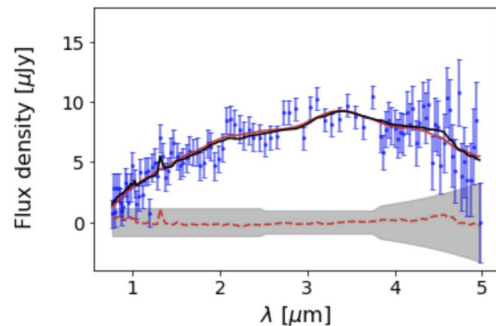
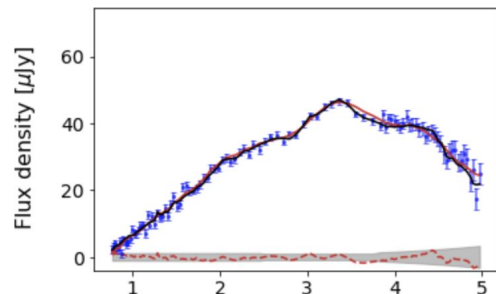
Redshifts from low-resolution spectroscopy

- With weak continuum prior, scan flux measurements for emission lines to refine redshifts
- From emission line information:
 - 5M with $dz < 0.003(1+z)$
 - 10M with $dz < 0.01(1+z)$

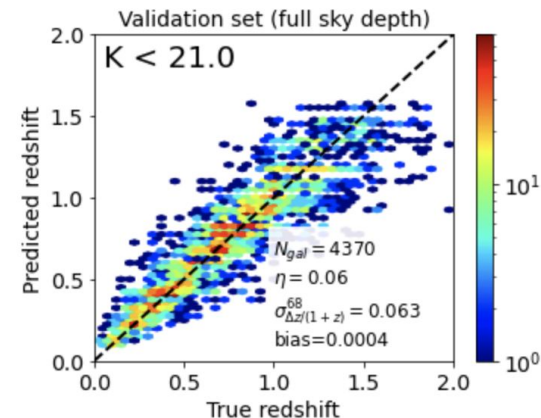
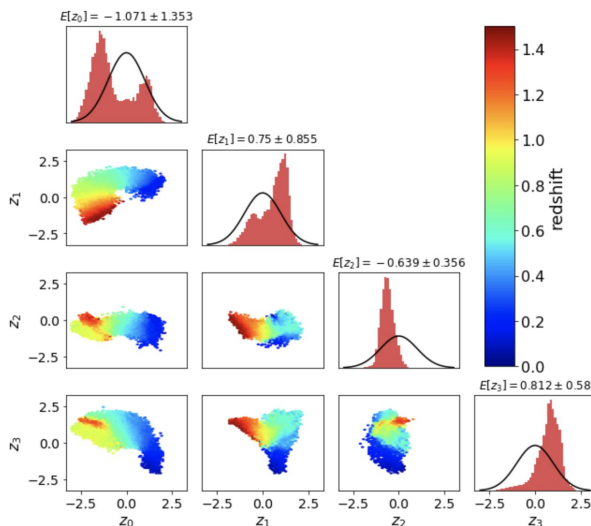


(Feder+2023)

SED/redshift modeling with variational autoencoders



VAE latent space distribution





SPHEREx F2F Meeting, September 2023



Thanks for listening!