

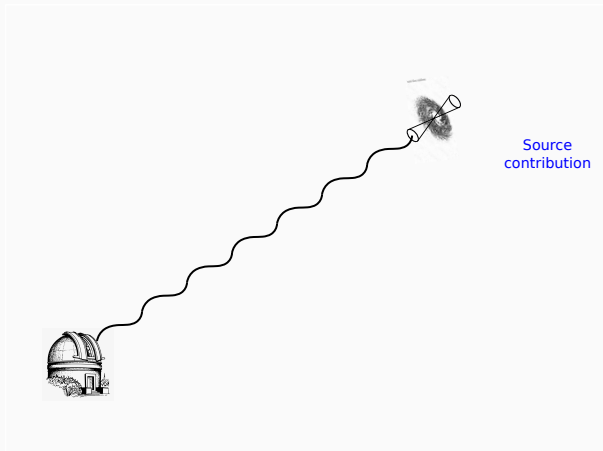
WEAVEify: Mock making code for WEAVE

Prakash Gaikwad

Dec, 2023

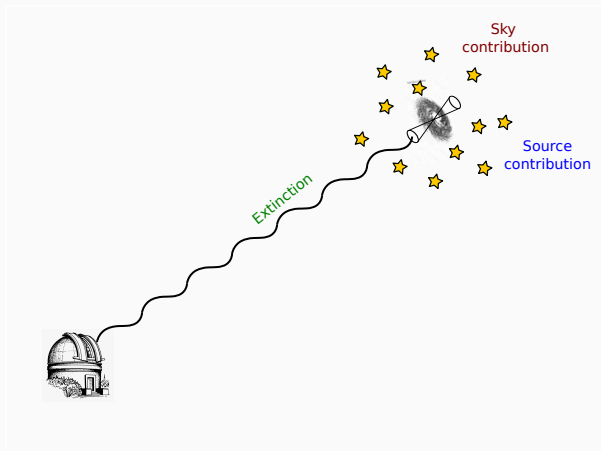


- Motivation and Overview
- Basic implementation and Updates
- Work in progress



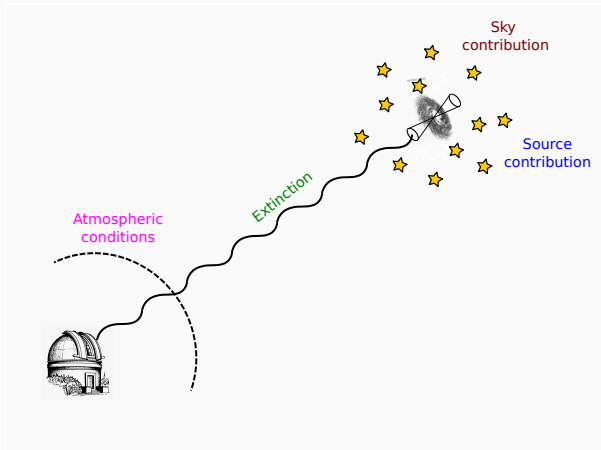
1. Observation Specification : photon count in FoV

WEAVEify: Overview



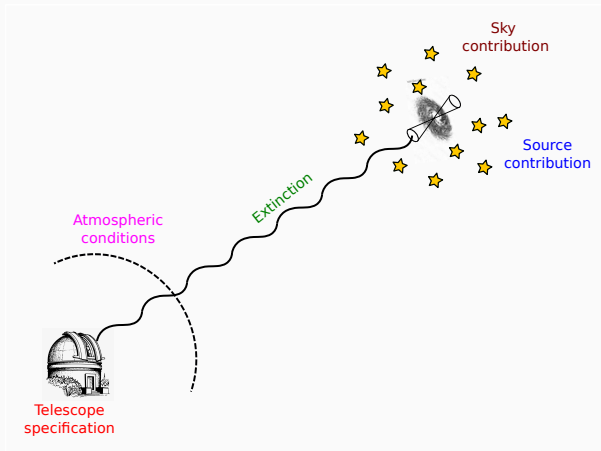
1. Observation Specification : photon count in FoV

WEAVEify: Overview

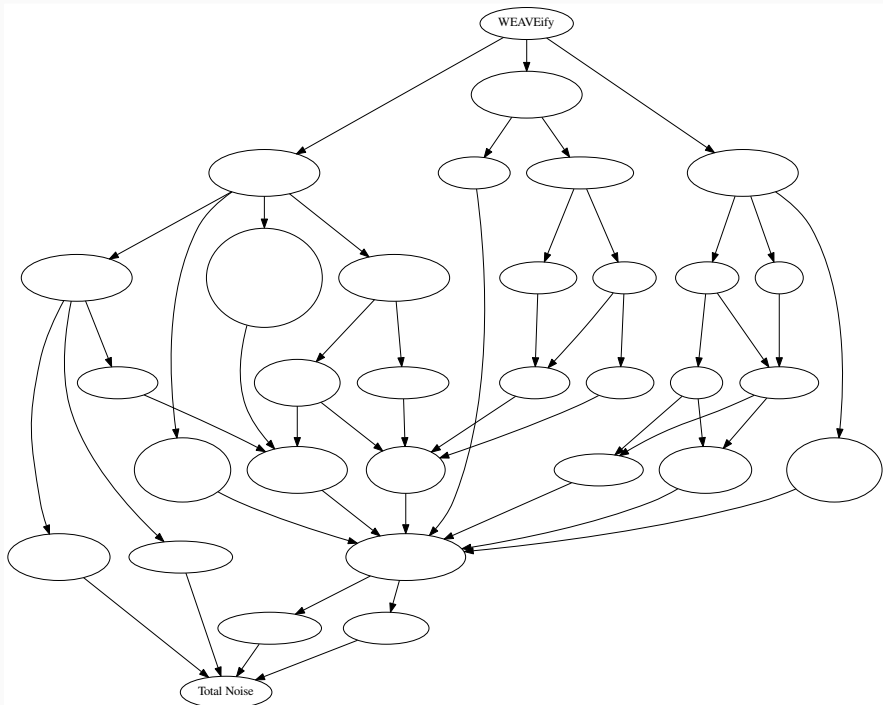


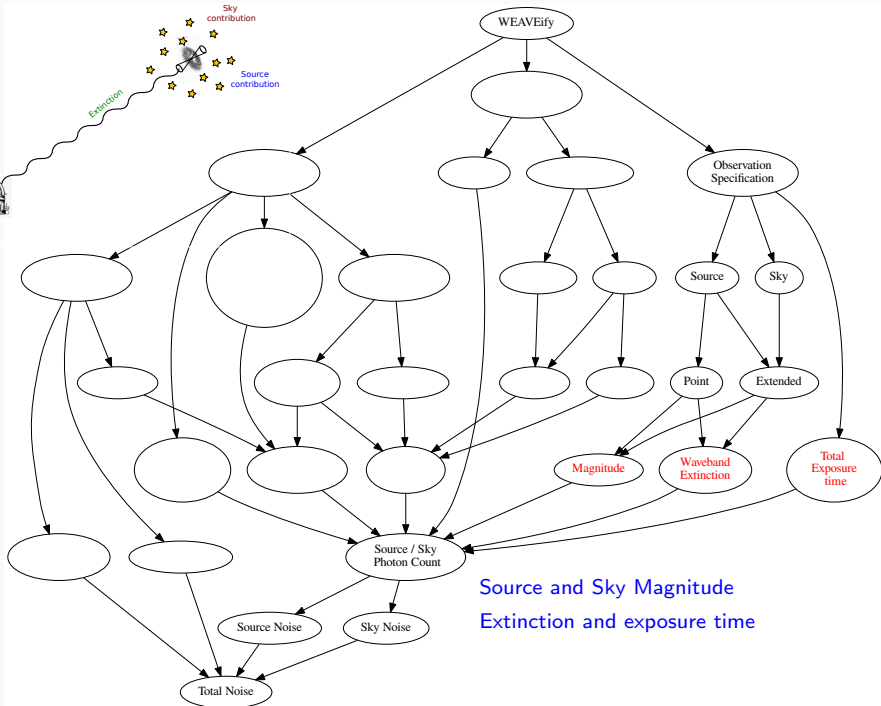
1. Observation Specification : photon count in FoV
2. Atmospheric conditions : Air density and turbulent airflow

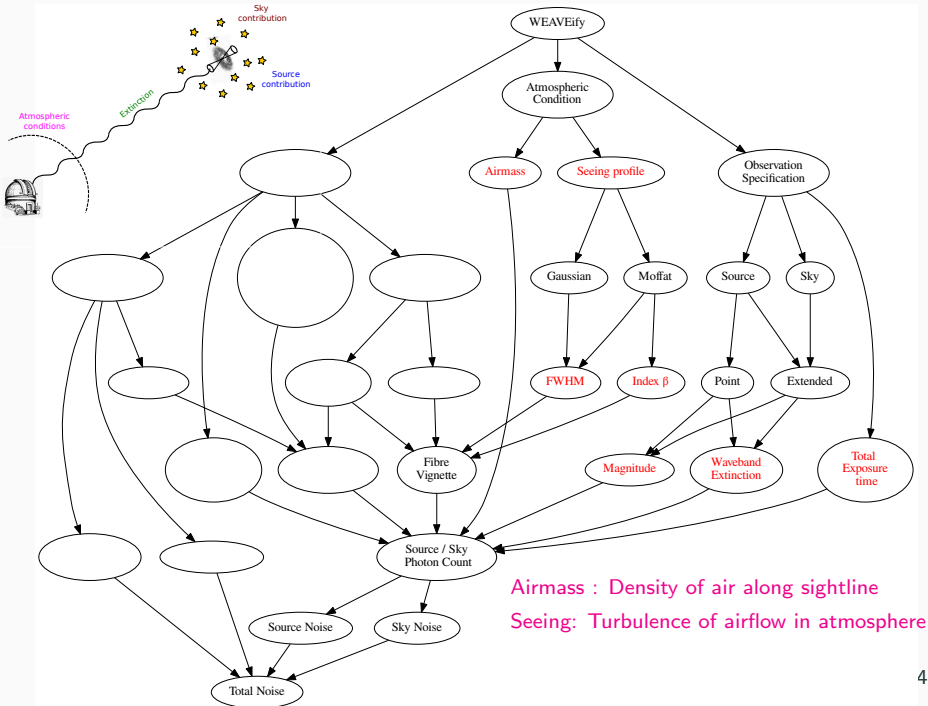
WEAVEify: Overview

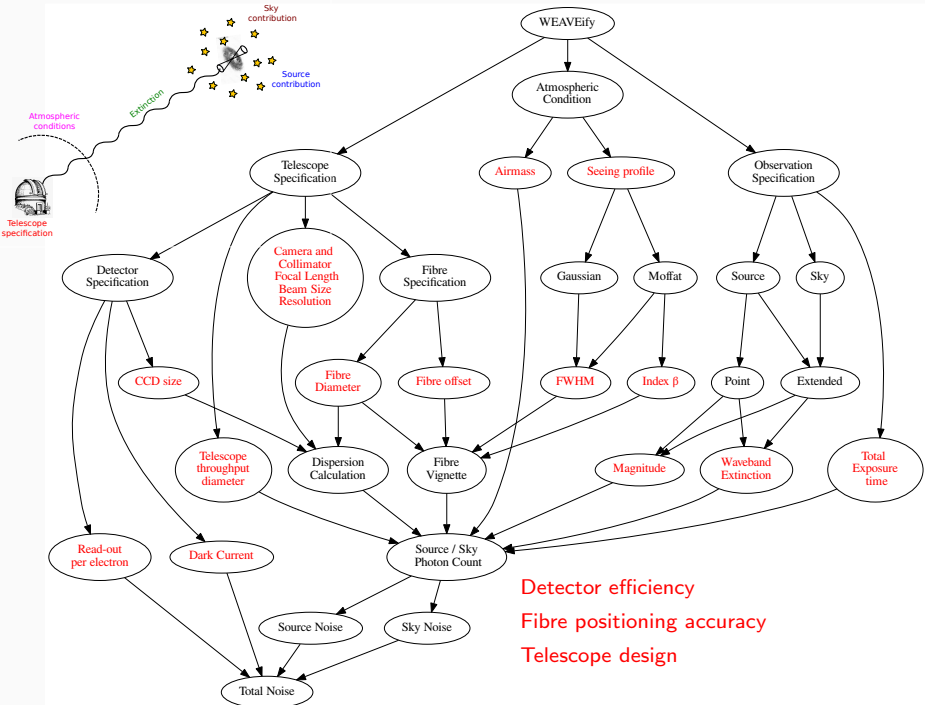


1. Observation Specification : photon count in FoV
2. Atmospheric conditions : Air density and turbulent airflow
3. Telescope specification : Engineering design and instrument efficiency

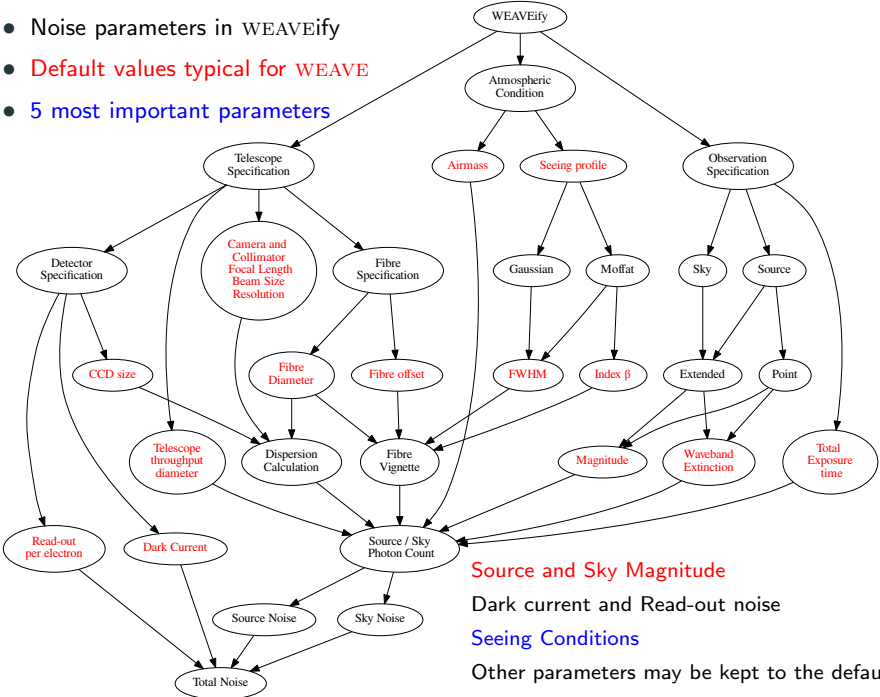








- Noise parameters in WEAVEify
- Default values typical for WEAVE
- 5 most important parameters



Source and Sky Magnitude

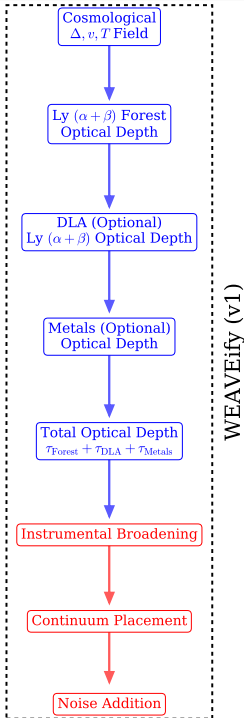
Dark current and Read-out noise

Seeing Conditions

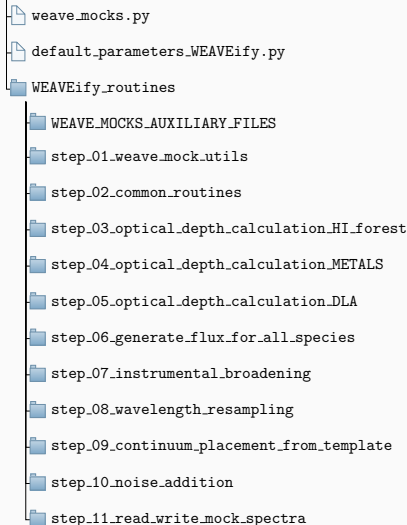
Other parameters may be kept to the default values

- Basic Equation
- $N_{\text{source}} = 10^{-m/2.5} \times N_{\text{photons, } m=0} \times f_{\text{atm}}(\text{airmass}) \times t_{\text{exp}} \times \eta_{\text{telescope}} \times A_{\text{unobst}}$
- m is magnitude of source in given wave band.
- $N_{\text{photons, } m=0} \Rightarrow \text{Photons/sec/\AA/m}^2$ giving $m = 0$ at the top of atmosphere
- $f_{\text{atm}} \Rightarrow \text{Transmission of atmosphere at given airmass}$
- $t_{\text{exp}} \Rightarrow \text{Exposure time in sec}$
- $\eta_{\text{throughput}} \Rightarrow \text{Total throughput of telescope}$
- $A_{\text{unobst}} \Rightarrow \text{Unobstructed area of main mirror in m}^2$.
- $N_{\text{sky}} \Rightarrow \text{Similar to } N_{\text{source}} \text{ except for sky brightness magnitude } m_{\text{sky}}.$
- Poisson Noise, $\sigma = \sqrt{N}$, $\sigma_{\text{tot}} = \sqrt{\sigma_{\text{source}}^2 + \sigma_{\text{sky}}^2 + \sigma_{\text{dark}}^2 + \sigma_{\text{read-out}}^2}$.
- Signal-to-noise Ratio $\text{SNR} = N_{\text{source}}/\sigma_{\text{tot}}$

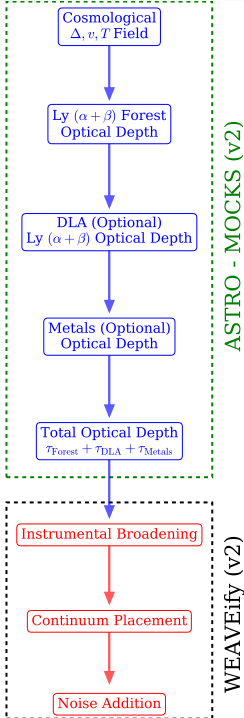
WEAVEify Updates (Past 1 year)



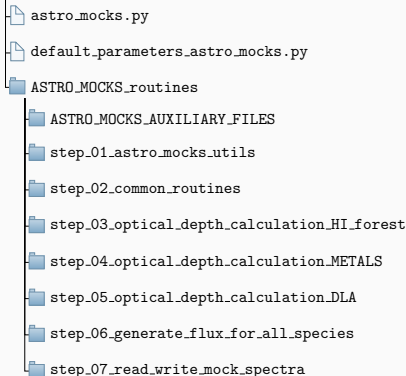
WEAVE MOCKS CODE



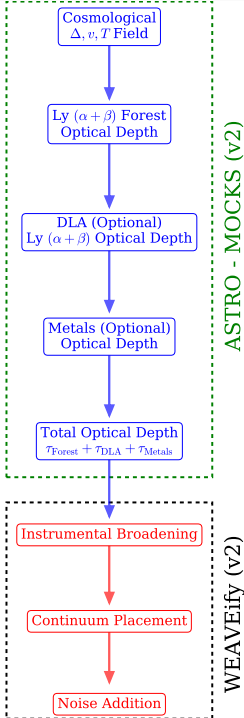
- WEAVEIFY (v1) uses cosmological mocks and generates optical depths and account for instrumental effects.



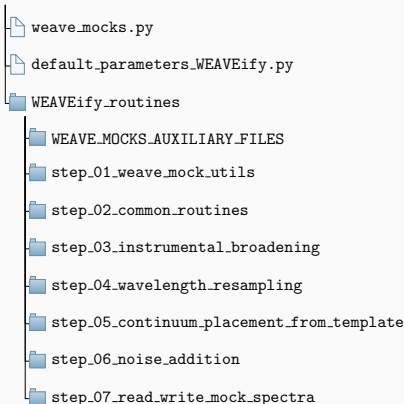
ASTRO MOCKS_CODE



- ASTRO-MOCKS (v2) uses cosmological mocks and generates optical depths.
- ASTRO-MOCKS can be replaced by other simulations e.g., LyCoLRe, Eagle etc.
- ASTRO-MOCKS output can be post-processed with additional features e.g., realistic metal profile injection, DLA addition etc.



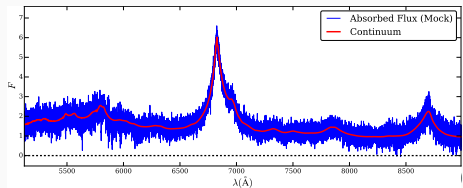
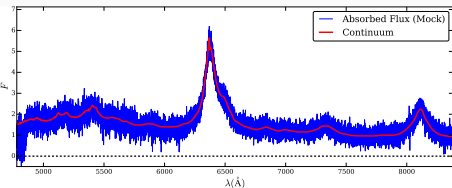
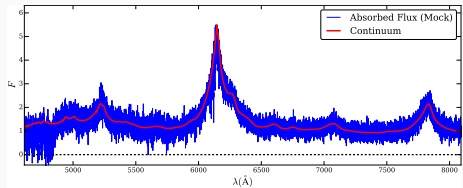
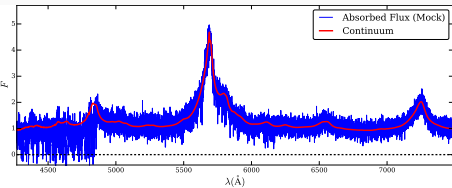
WEAVEify



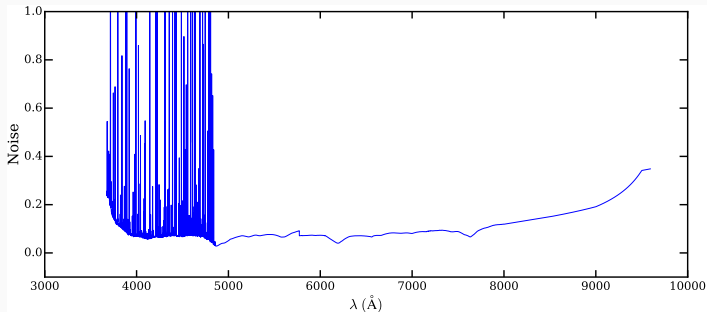
- WEAVEIFY (v2) adds all the features related to instrumental effects.
- Features: Instrumental broadening, continuum placement and noise addition.
- Inputs required for WEAVEIFY: Flux array 1d, Wavelength array 1d, observational and telescope parameters

Continuum placement (Interpolation Error Issue)

- Discussion with Trystn : Some wavelength regions were out of interpolation range of continuum.
- Continuum issues at specific redshifts : $z \sim 3.681, 4.057, 4.241, 4.617, \dots$.
- This issue has now been fixed in WEAVEIFY (v1 and v2).
- High redshift QSO continuum ($z \sim 8$) can be included in the WEAVEIFY (v1 and v2)

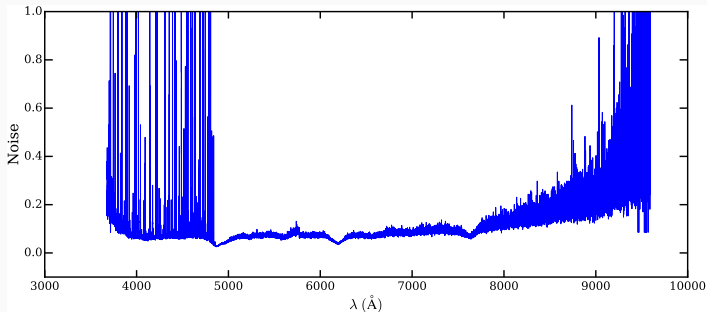


Uncertainty on SNR



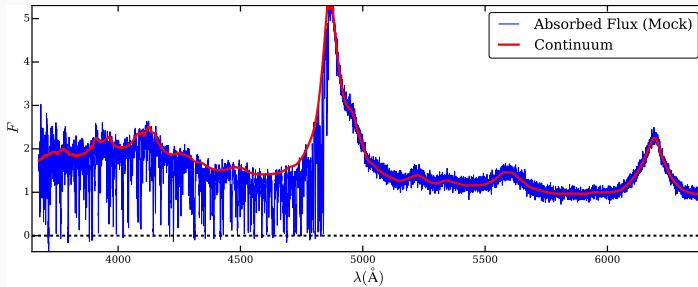
- Earlier version of WEAVEify: When we plot $1/\text{SNR}$ was too smooth
- That is there were no uncertainties on SNR
- We now add uncertainties on SNR similar to OpR3 mocks
- A new variable `f_scale_snr_std` is introduced that controls the amount of uncertainties on SNR
- `f_scale_snr_std=1` $\Rightarrow$ Uncertainty on SNR similar to OpR3 mocks
- `f_scale_snr_std=0` $\Rightarrow$ No uncertainty on SNR
- `f_scale_snr_std` can take any values ≥ 0 .

Uncertainty on SNR



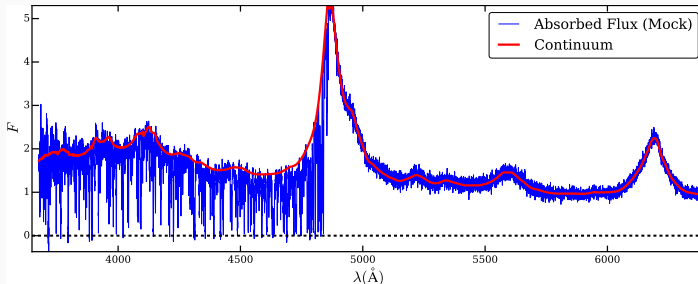
- Earlier version of WEAVEify: When we plot $1/\text{SNR}$ was too smooth
- That is there were no uncertainties on SNR
- We now add uncertainties on SNR similar to OpR3 mocks
- A new variable `f_scale_snr_std` is introduced that controls the amount of uncertainties on SNR
- `f_scale_snr_std=1` $\Rightarrow$ Uncertainty on SNR similar to OpR3 mocks
- `f_scale_snr_std=0` $\Rightarrow$ No uncertainty on SNR
- `f_scale_snr_std` can take any values ≥ 0 .

Uncertainty on SNR

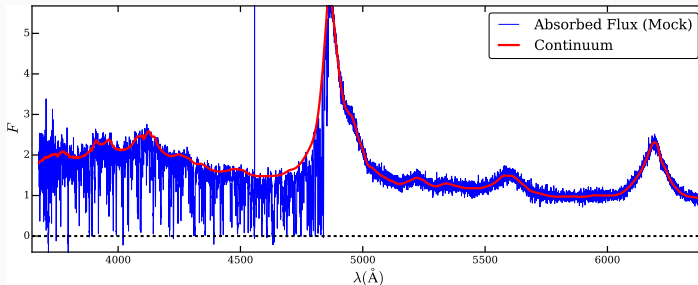


Without SNR
uncertainty

Uncertainty on SNR



Without SNR
uncertainty



With SNR
uncertainty

Occasionally pixels
have large noise

Work in Progress

- WEAVEify

- Improving the part of the WEAVEify for uncertainty in SNR per pixels
- Correlated noise in OpR3 Mocks: Implementation in WEAVEify
- Observed throughput from WEAVE data?

- MOCK-MAKING

- Distribution of redshifts and magnitudes to generate mocks?
- WEAVEify is merged with Sherwood simulations by Mark (PhD. Student of Jamie Bolton)
- Few simulation boxes have been completed and can generate spectra.