

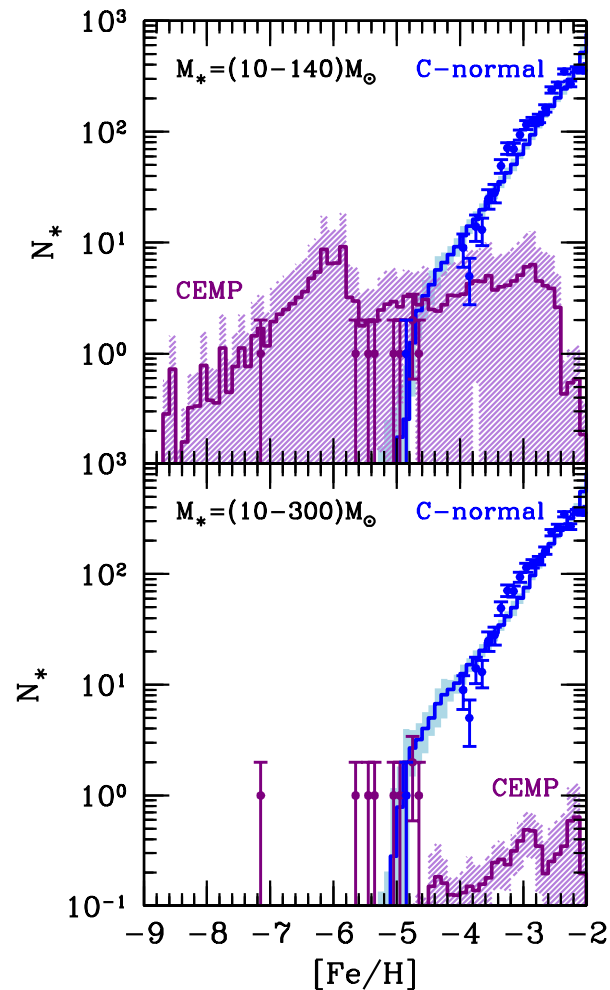
STELLAR PARAMETER DETERMINATION WITH J-PLUS USING ARTIFICIAL NEURAL NETWORKS

Devin D. Whitten

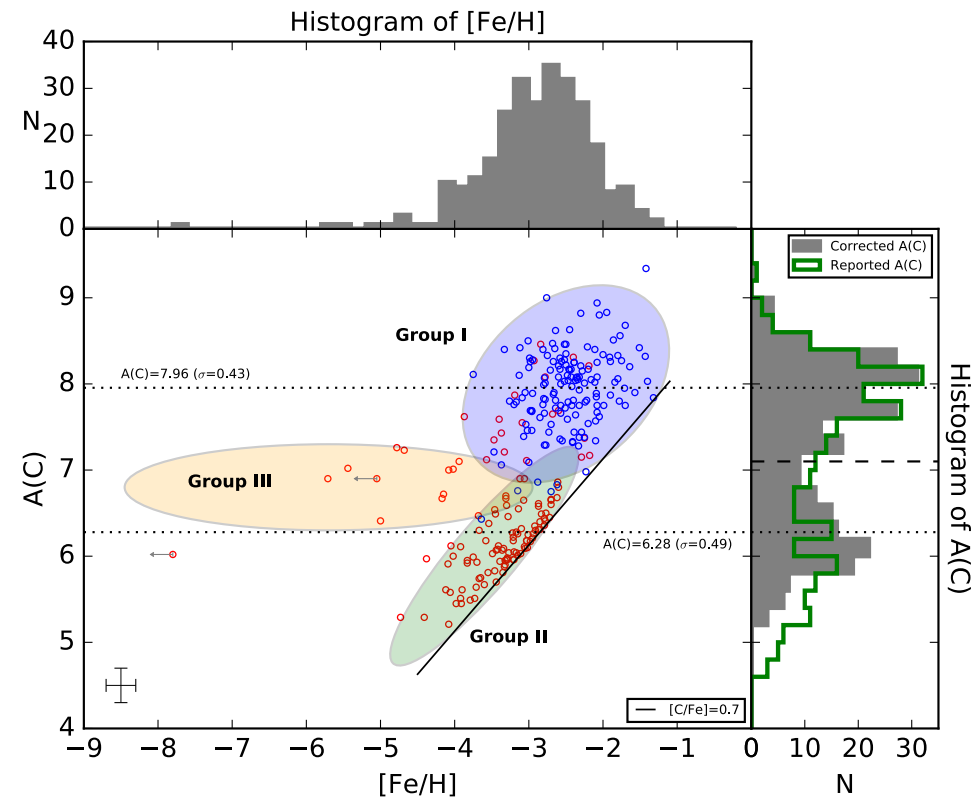


WHY DO STELLAR ABUNDANCES MATTER?

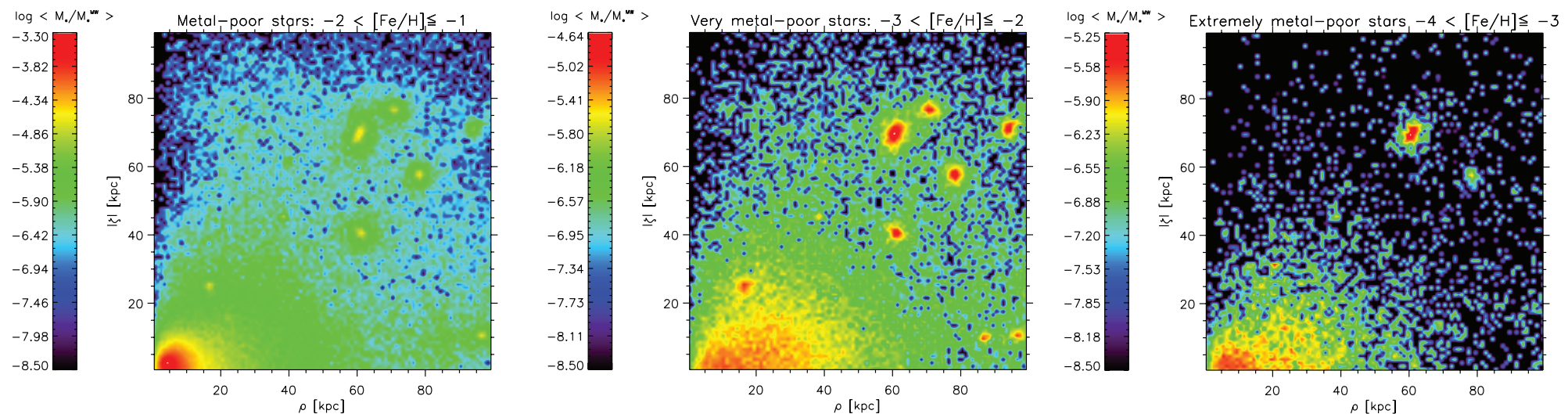
Salvadori et al. 2010



Yoon et al. 2016

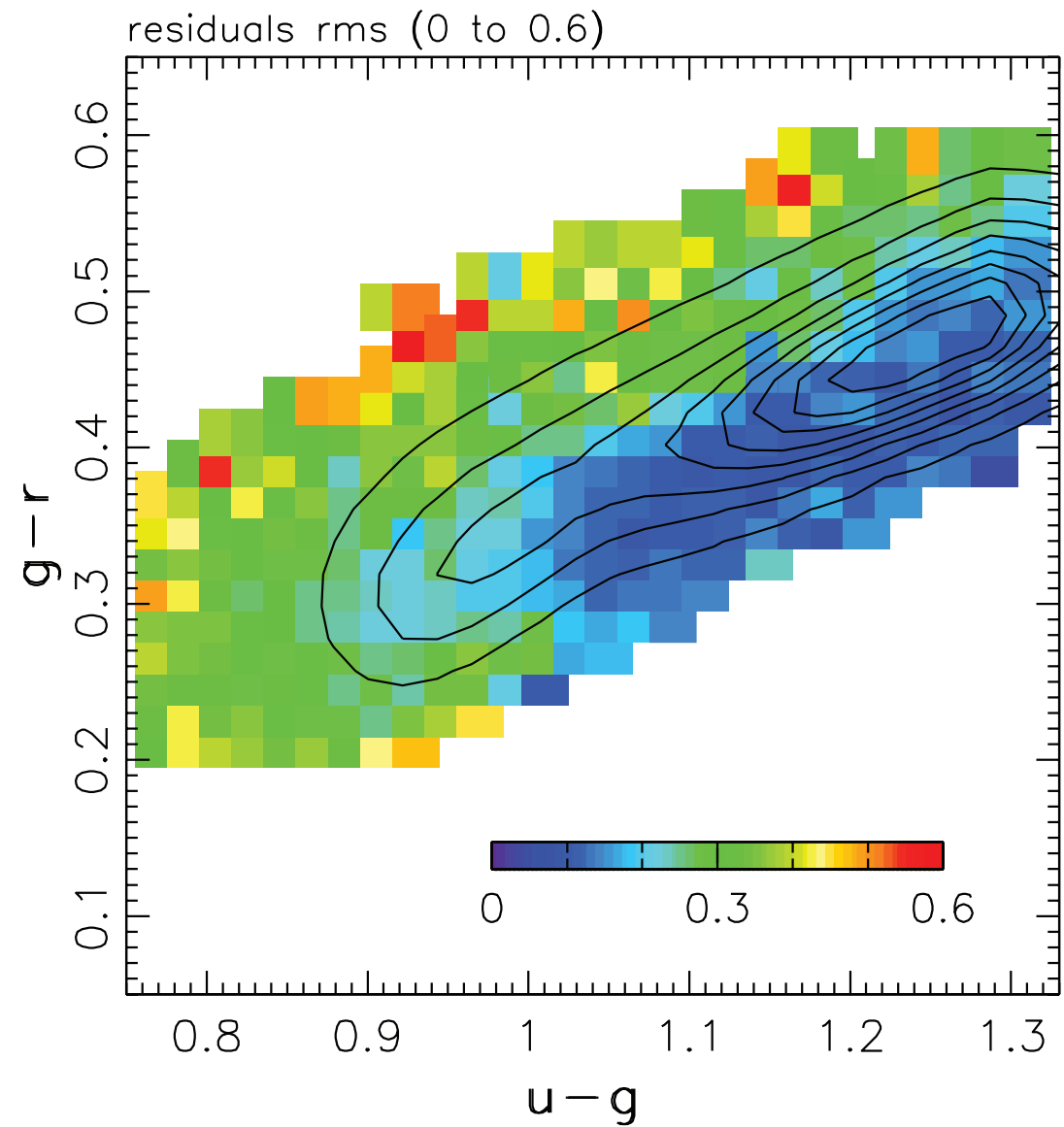
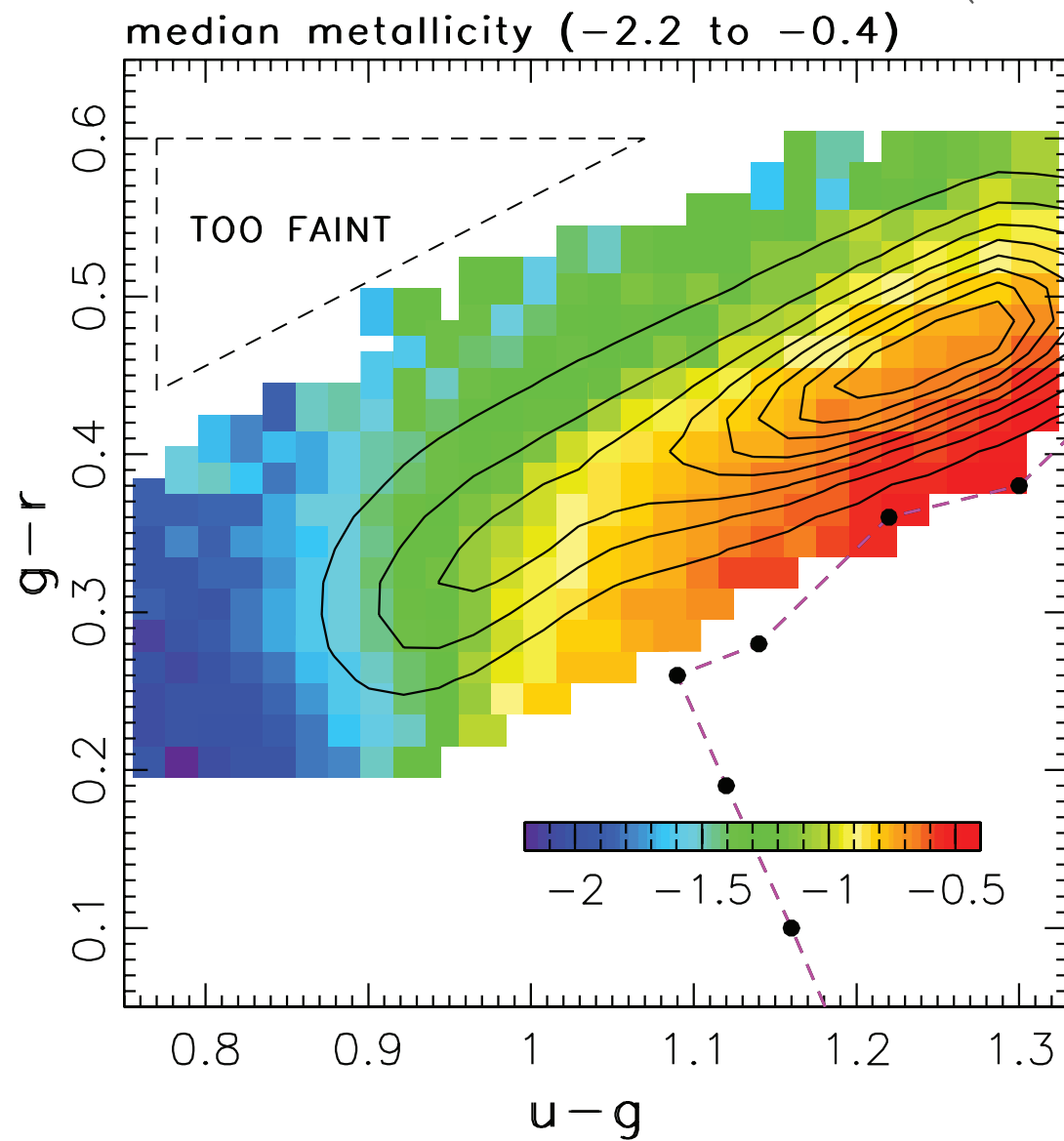


- Evidence for multiple Carbon-Enhanced Metal-Poor progenitors
- Metallicity Distribution Functions (MDFs) provide crucial constraints for simulations



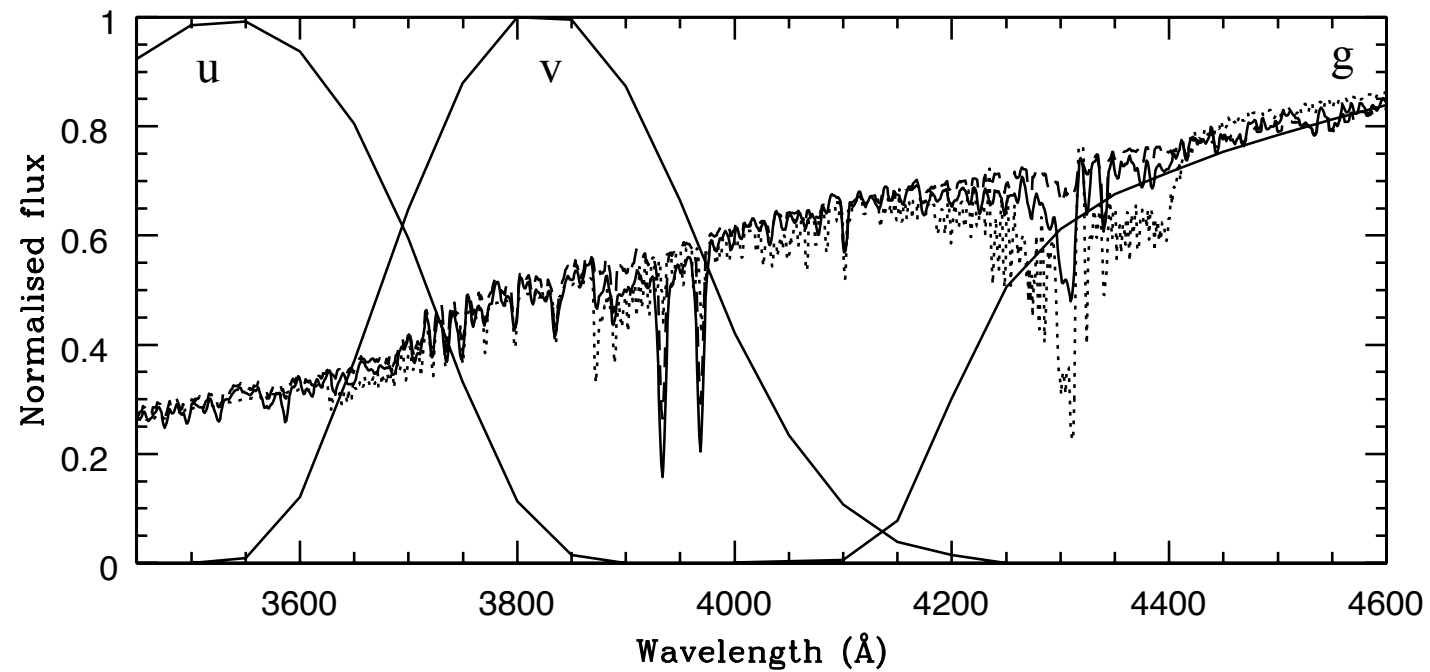
SDSS - UV EXCESS

(Ivezić et al. 2008)



- $(u-g)$ $(g-r)$ polynomials, saturation below $[\text{Fe}/\text{H}] < -2.2$

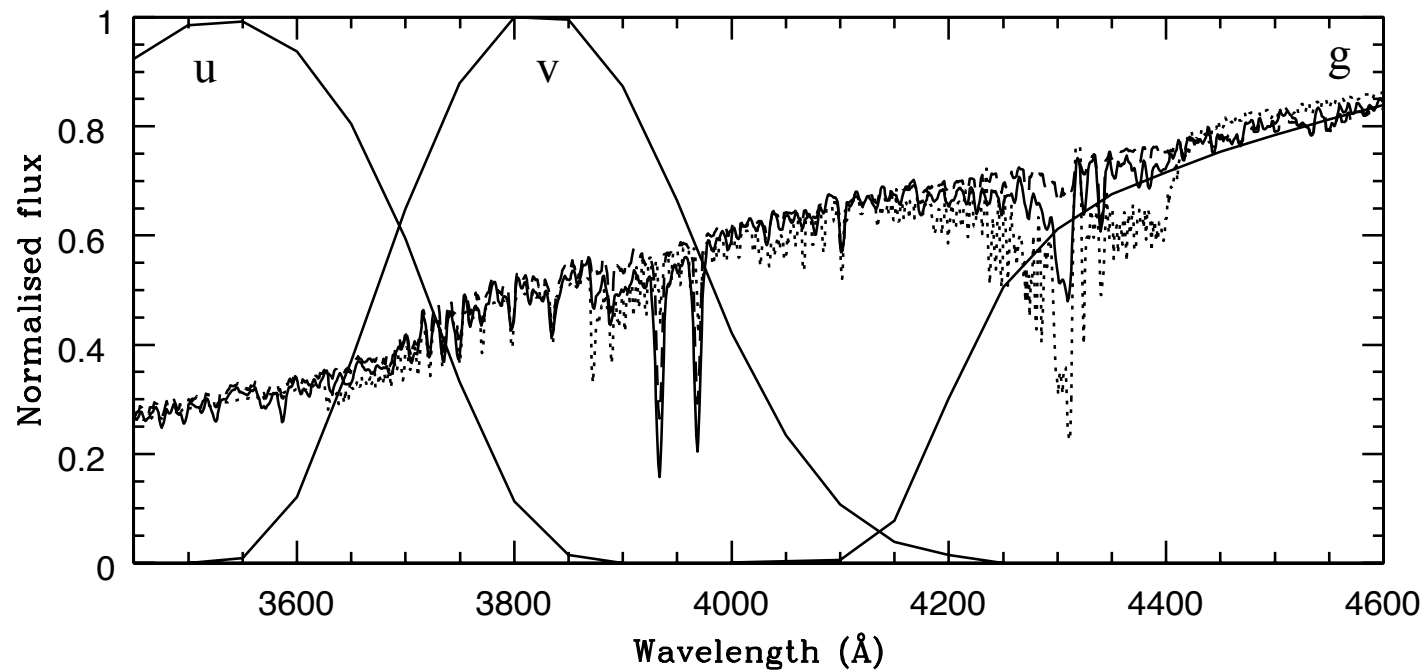
SKY MAPPER



(Keller et al. 2014)

- Australian National University Spring Observatory
- Broadly based on SDSS ugriz filter set
- Introduced intermediate-band v filter
- Anticipated $\sim 1,300$ EMP stars ($[\text{Fe}/\text{H}] < -3$)
- Found most metal-poor star known ($[\text{Fe}/\text{H}] < -7.1$)

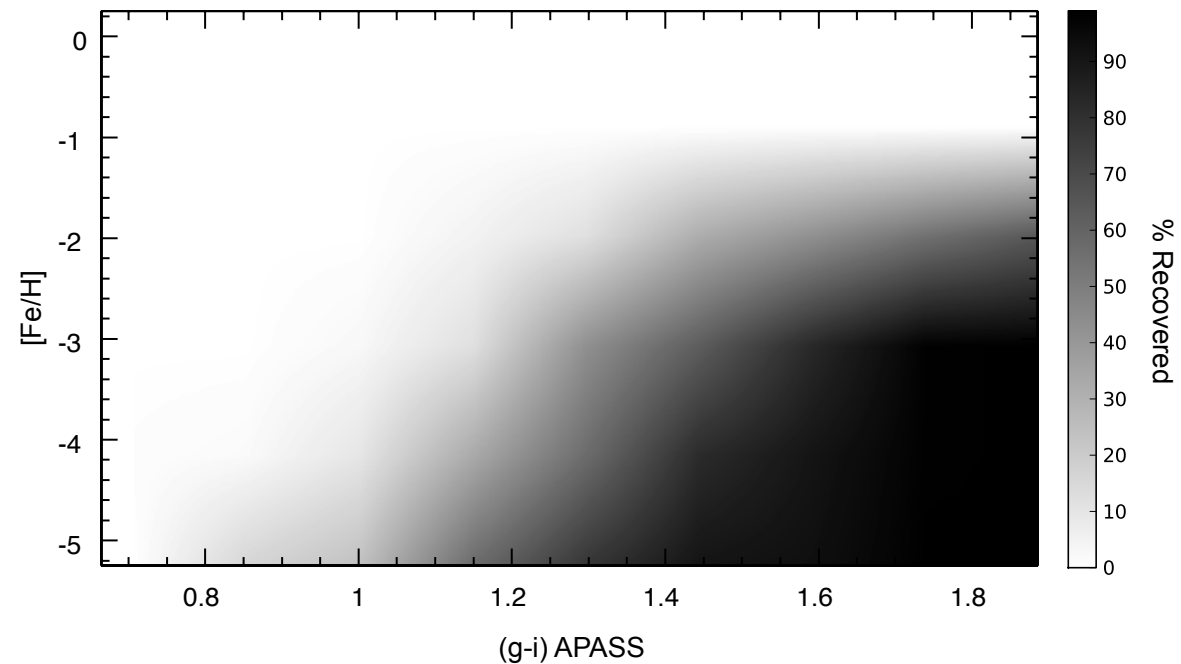
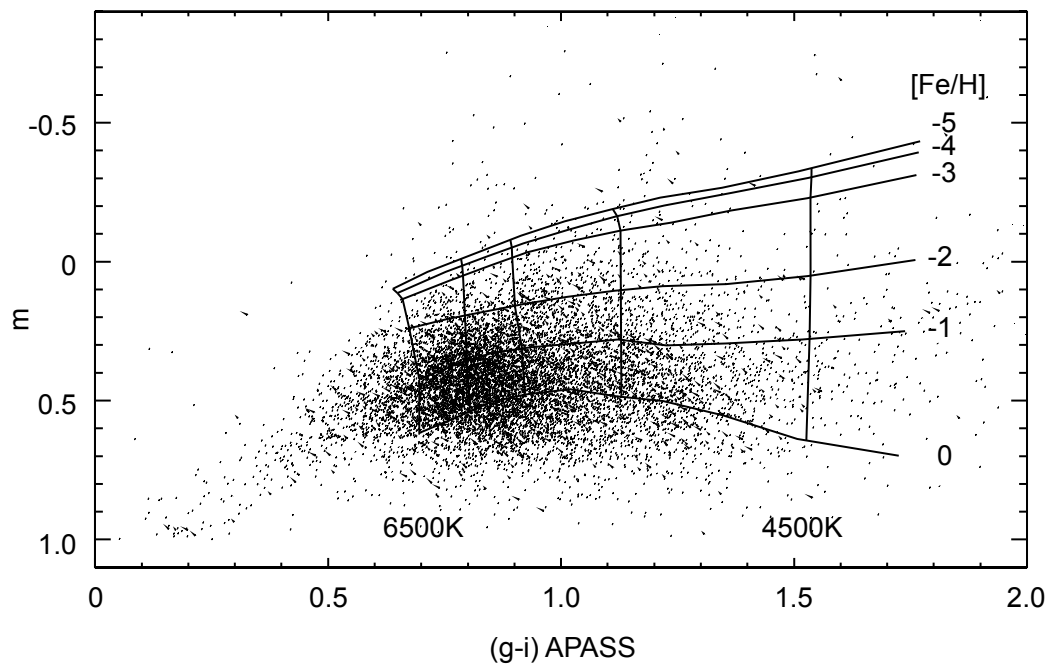
SKY MAPPER



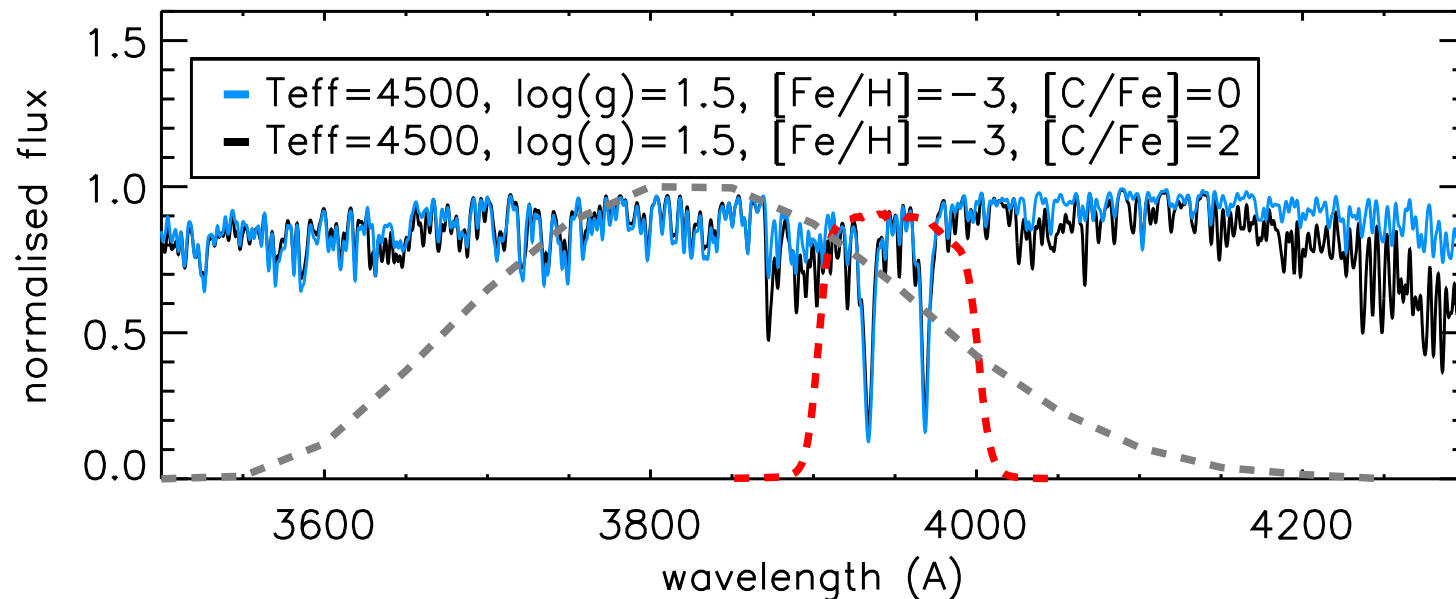
(Keller et al. 2014)

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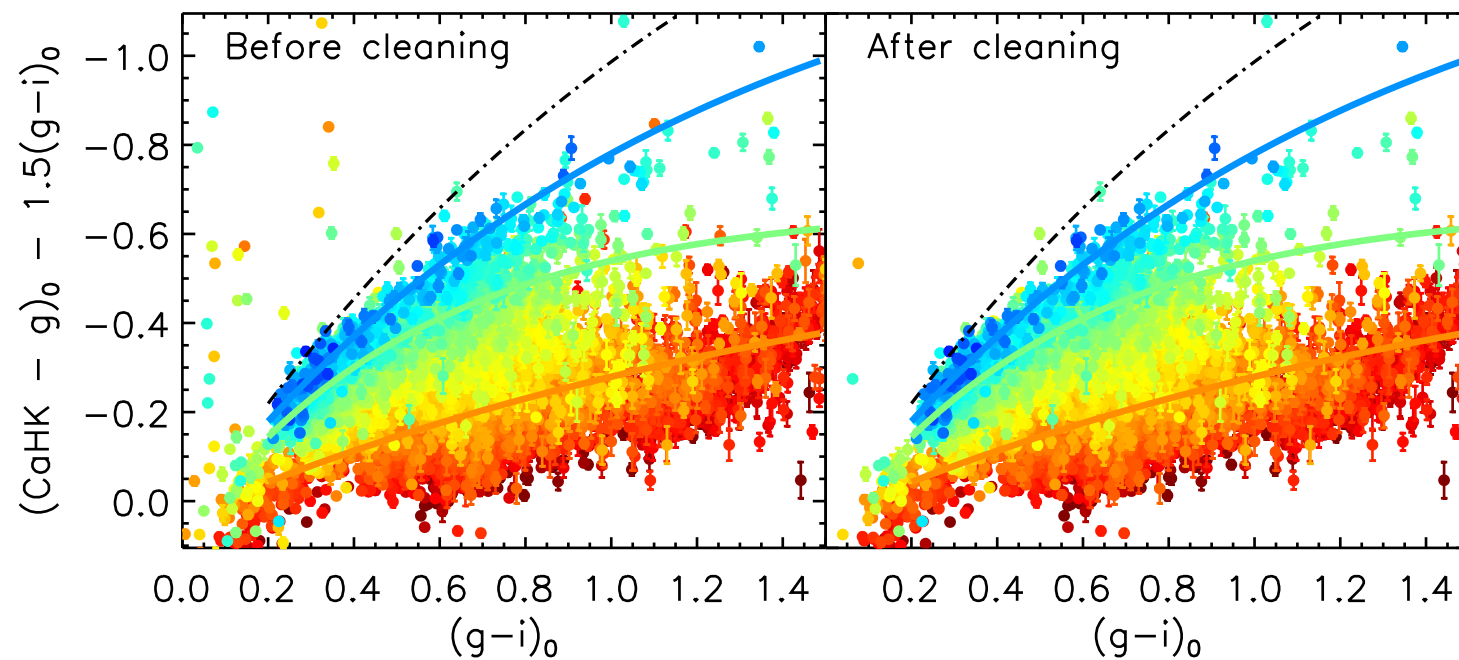
Metallicity sensitive color: $m = (v-g) - 2.0(g-i)$



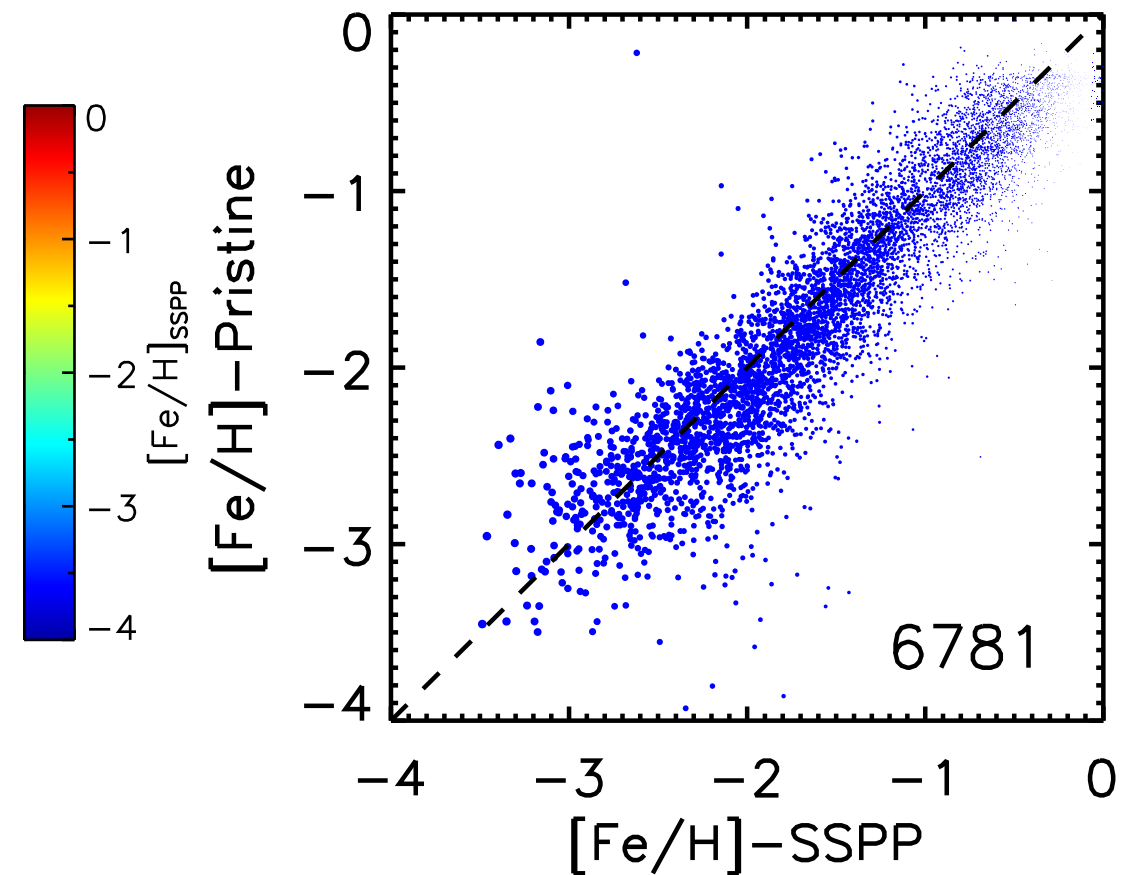
PRISTINE



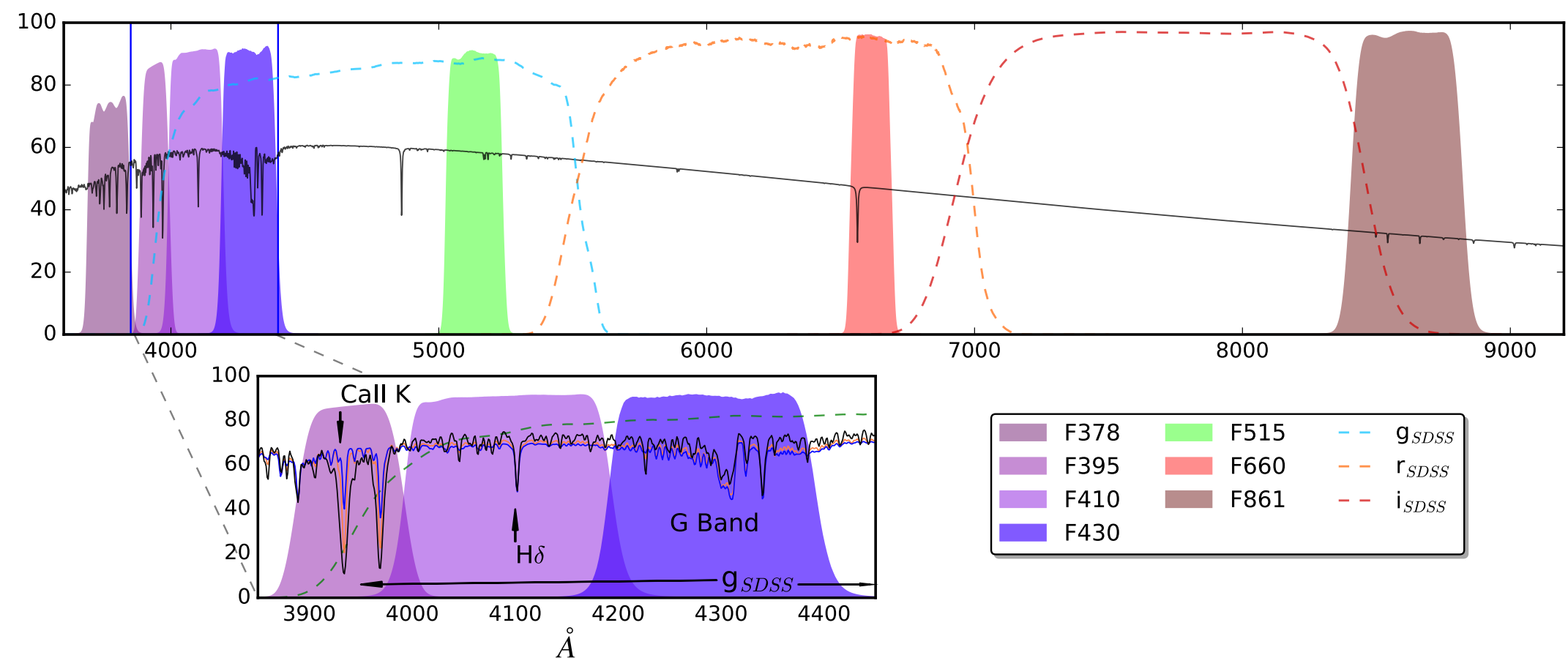
- 1,000deg² of the Galactic Halo, within SDSS
- 26% success rate for uncovering $[\text{Fe}/\text{H}] < -3.0$
- 80% of remaining candidates $[\text{Fe}/\text{H}] < -2.0$



(Starkenburg et al. 2017)

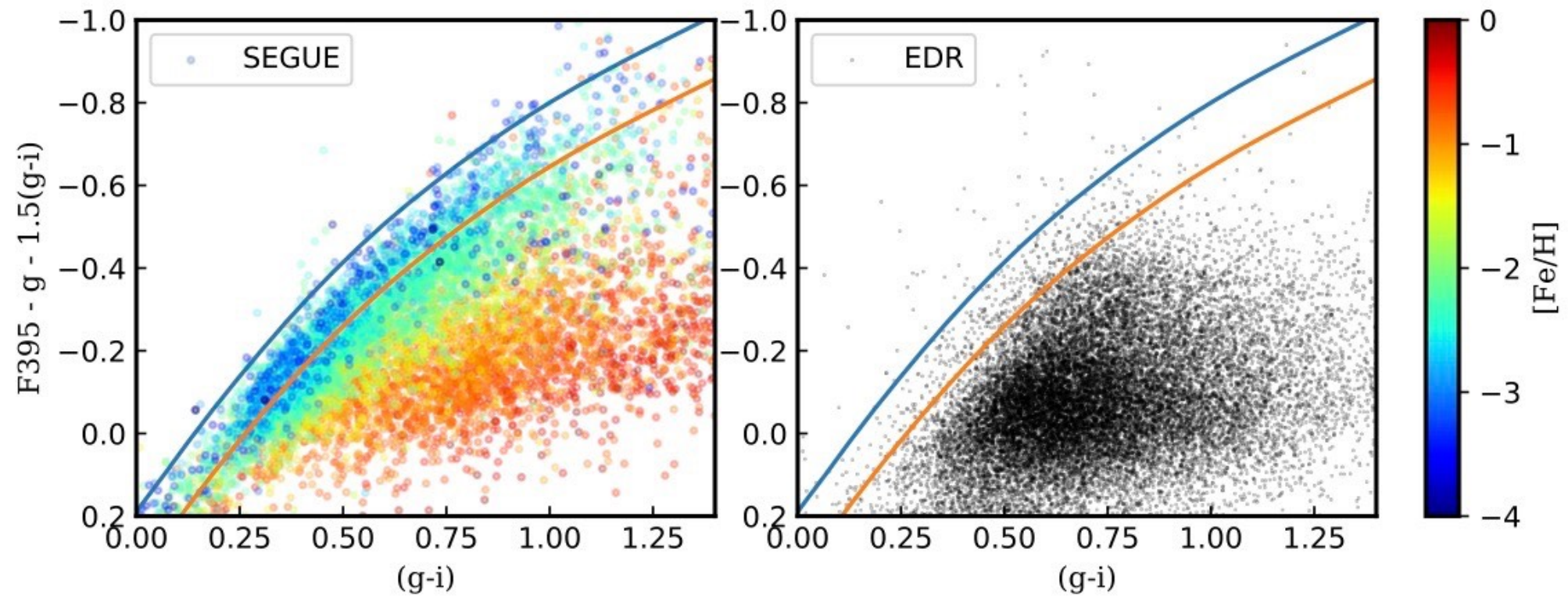


JAVALAMBRE PHOTOMETRIC LOCAL UNIVERSE SURVEY

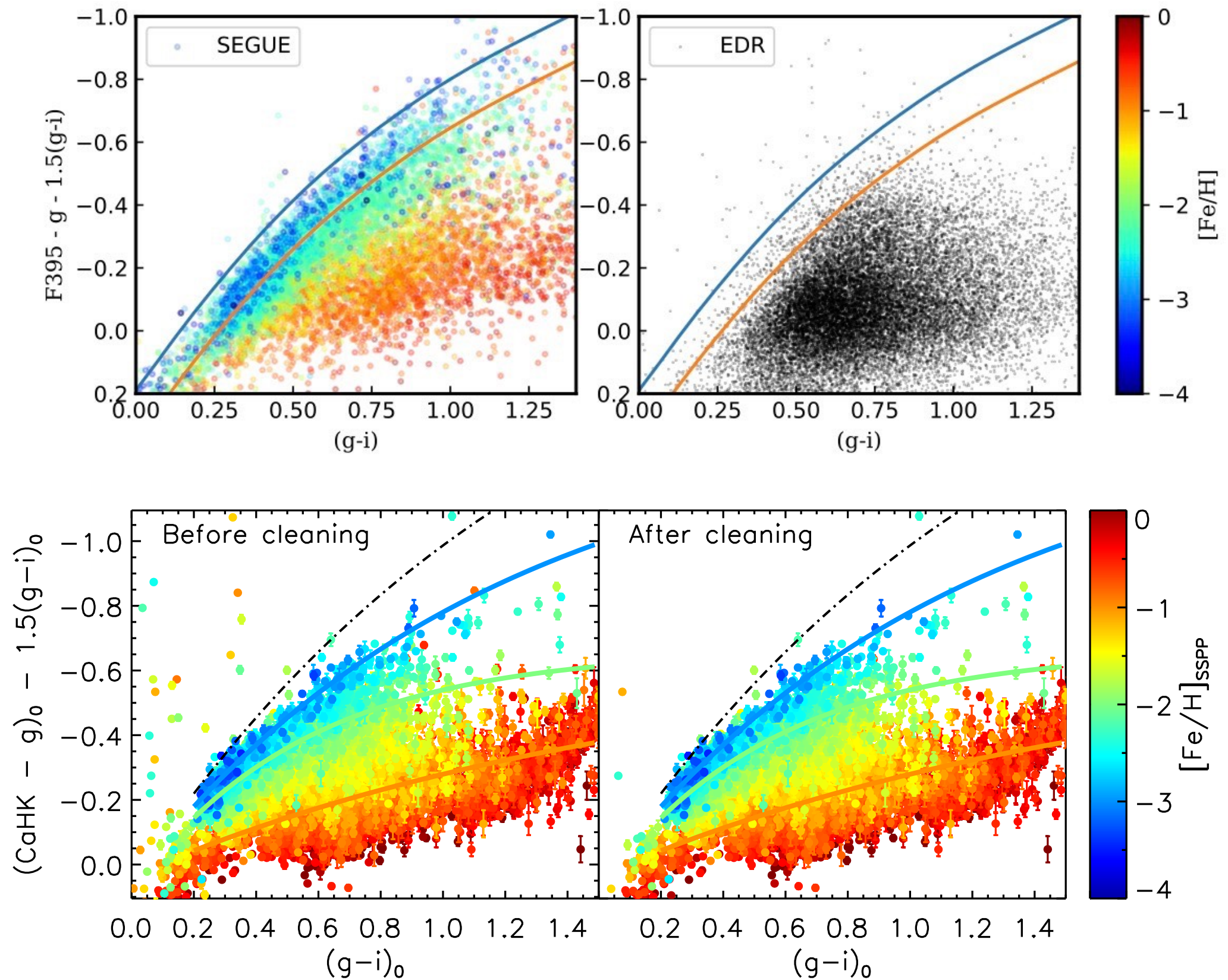


Name	Central Wavelength [nm]	FWHM [nm]	Comments
<i>u</i>	348.5	50.8	In common with J-PAS
<i>J0378</i>	378.5	16.8	[OII]; in common with J-PAS
<i>J0395</i>	395.0	10.0	Ca H+K
<i>J0410</i>	410.0	20.0	H δ
<i>J0430</i>	430.0	20.0	G-band
<i>g</i>	480.3	140.9	SDSS
<i>J0515</i>	515.0	20.0	Mgb Triplet
<i>r</i>	625.4	138.8	SDSS
<i>J0660</i>	660.0	13.8	H α ; in common with J-PAS
<i>i</i>	766.8	153.5	SDSS
<i>J0861</i>	861.0	40.0	Ca Triplet
<i>z</i>	911.4	140.9	SDSS

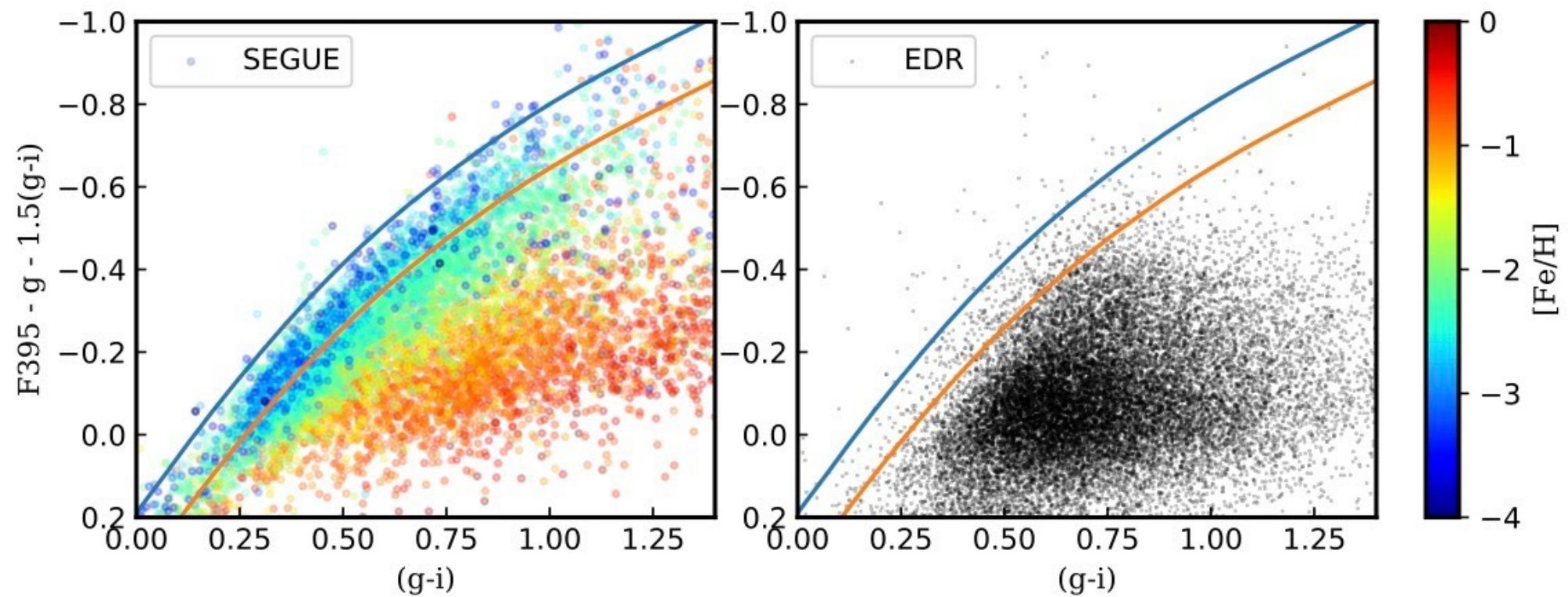
PRELIMINARY INVESTIGATION



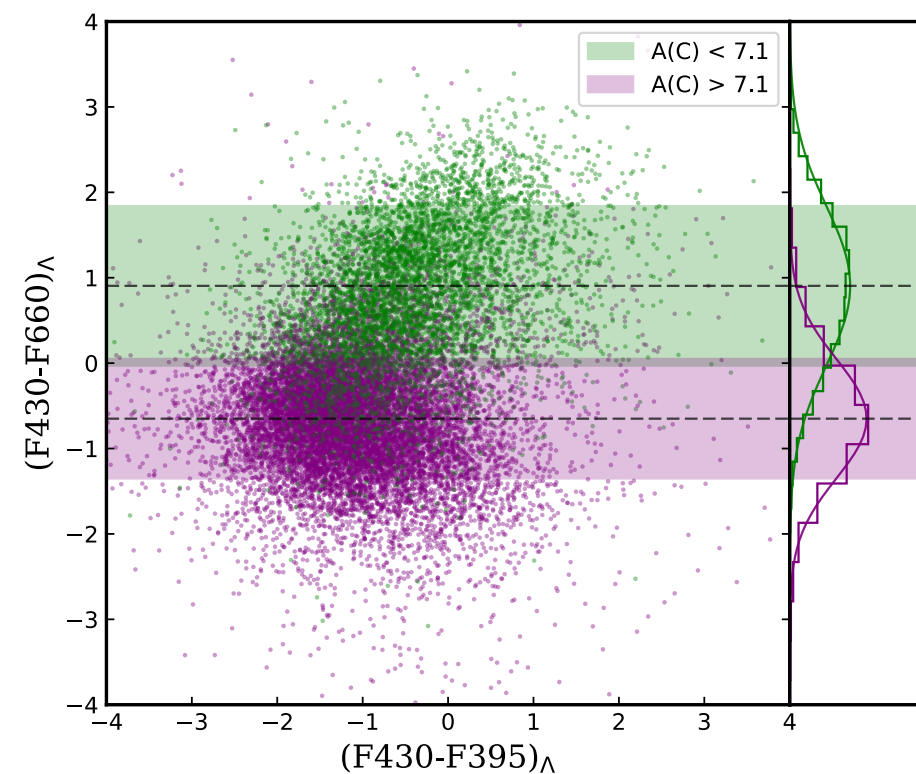
PRELIMINARY INVESTIGATION



PRELIMINARY INVESTIGATION

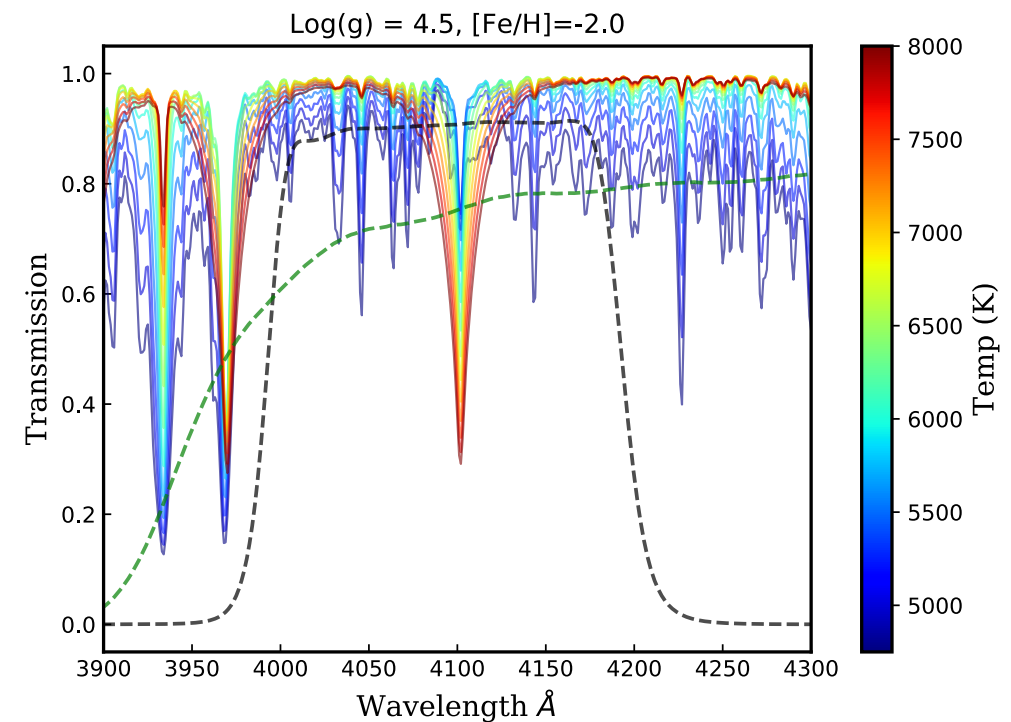
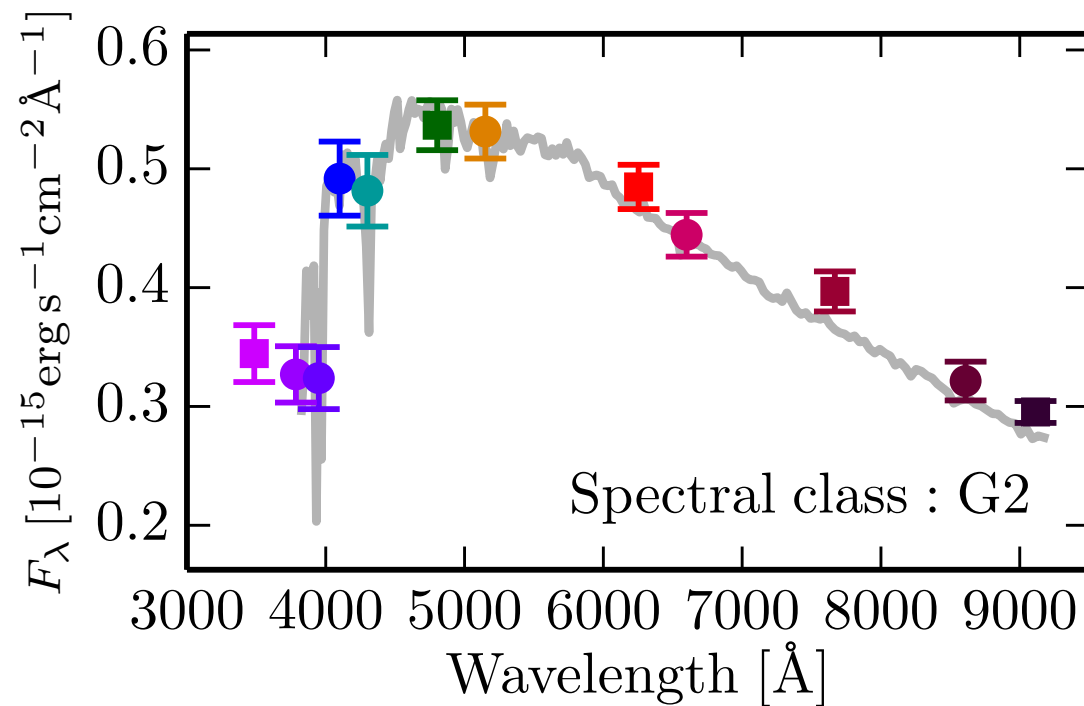


- Basic input de-correlation removes uninteresting input covariance

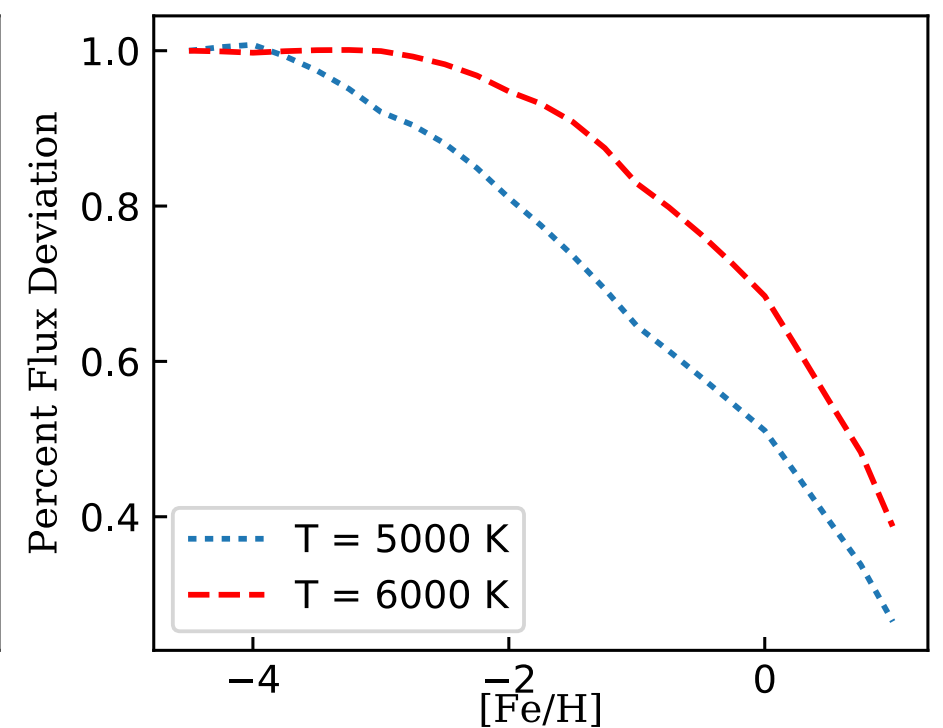
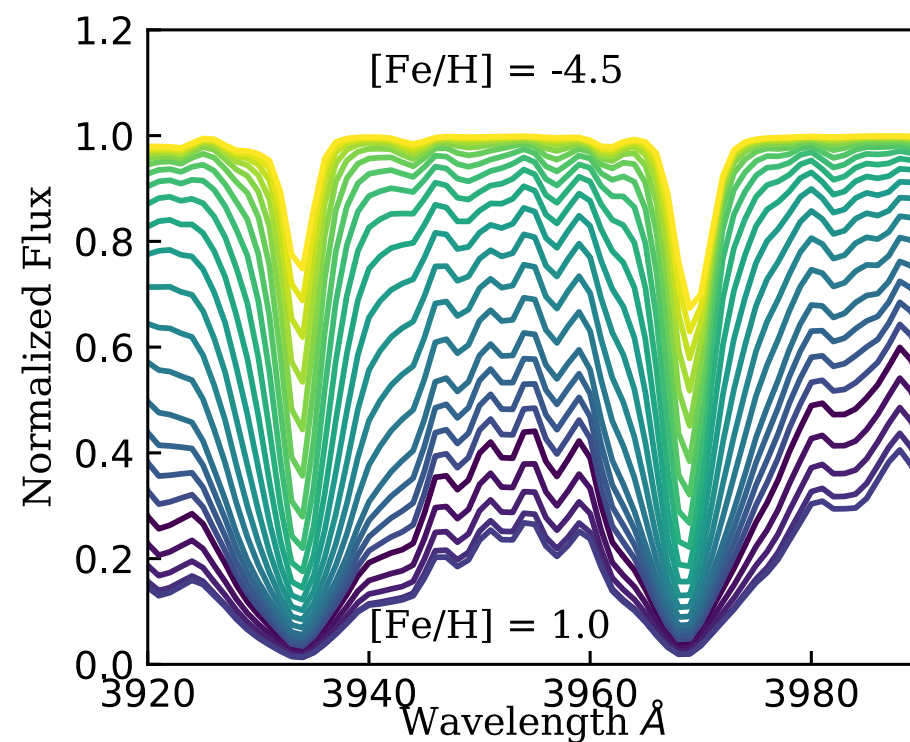


FEATURE SENSITIVITY

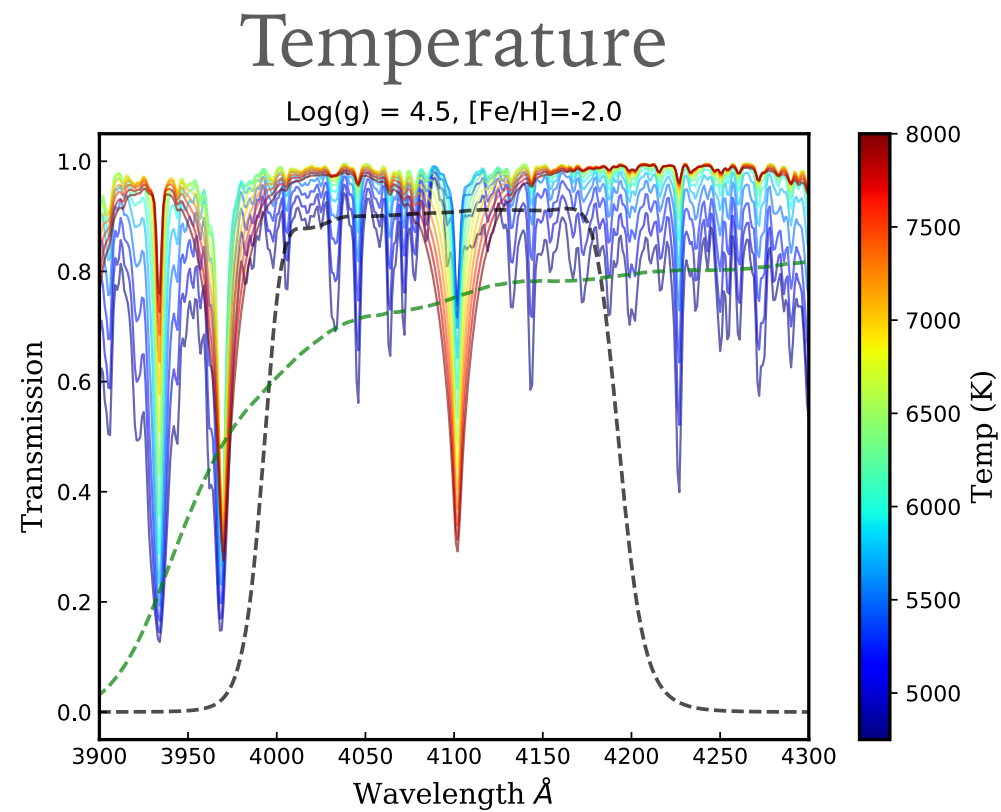
Temperature



Metallicity

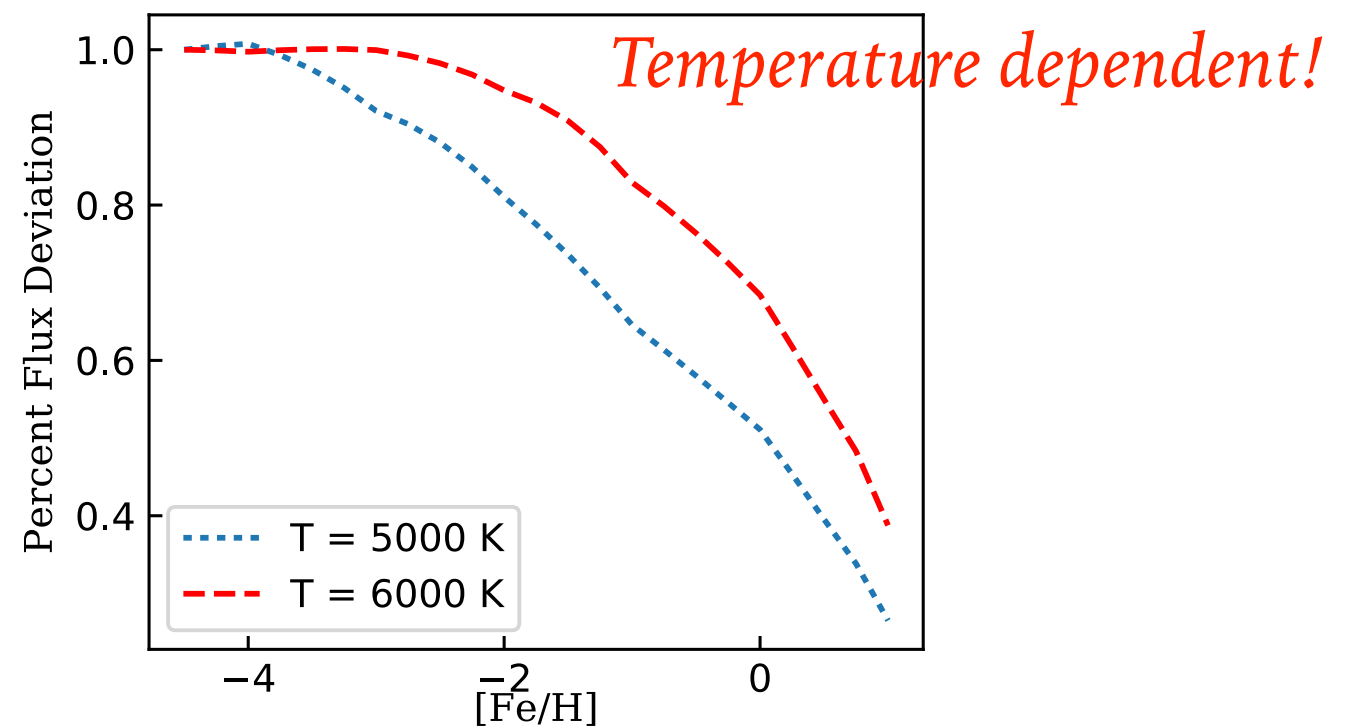
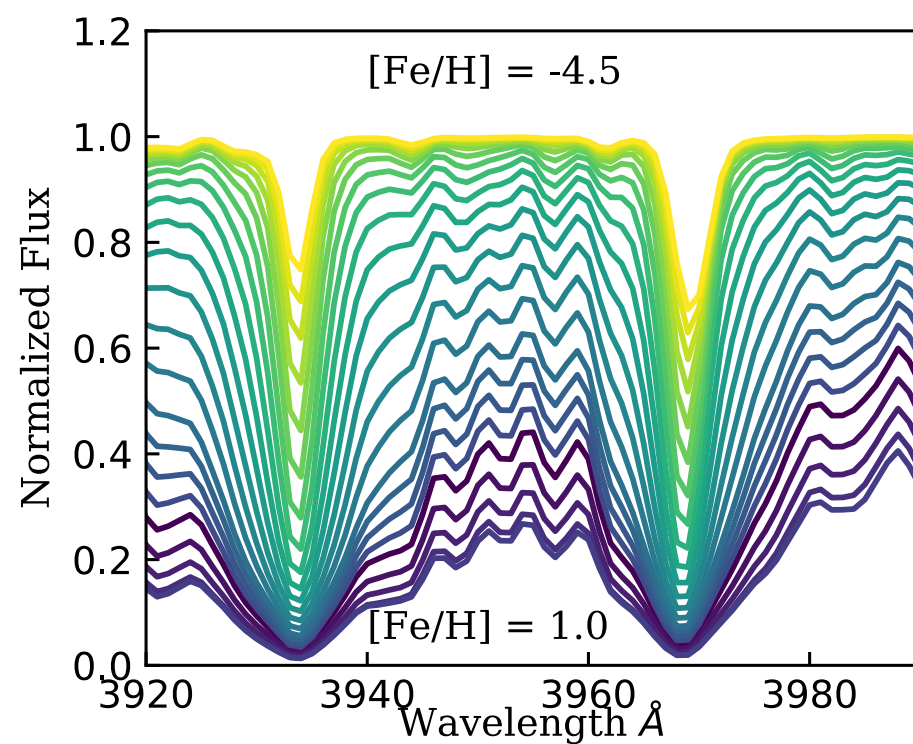


FEATURE SENSITIVITY



- Balmer line dependence
- Reconstruct blackbody distribution

Non-linear!



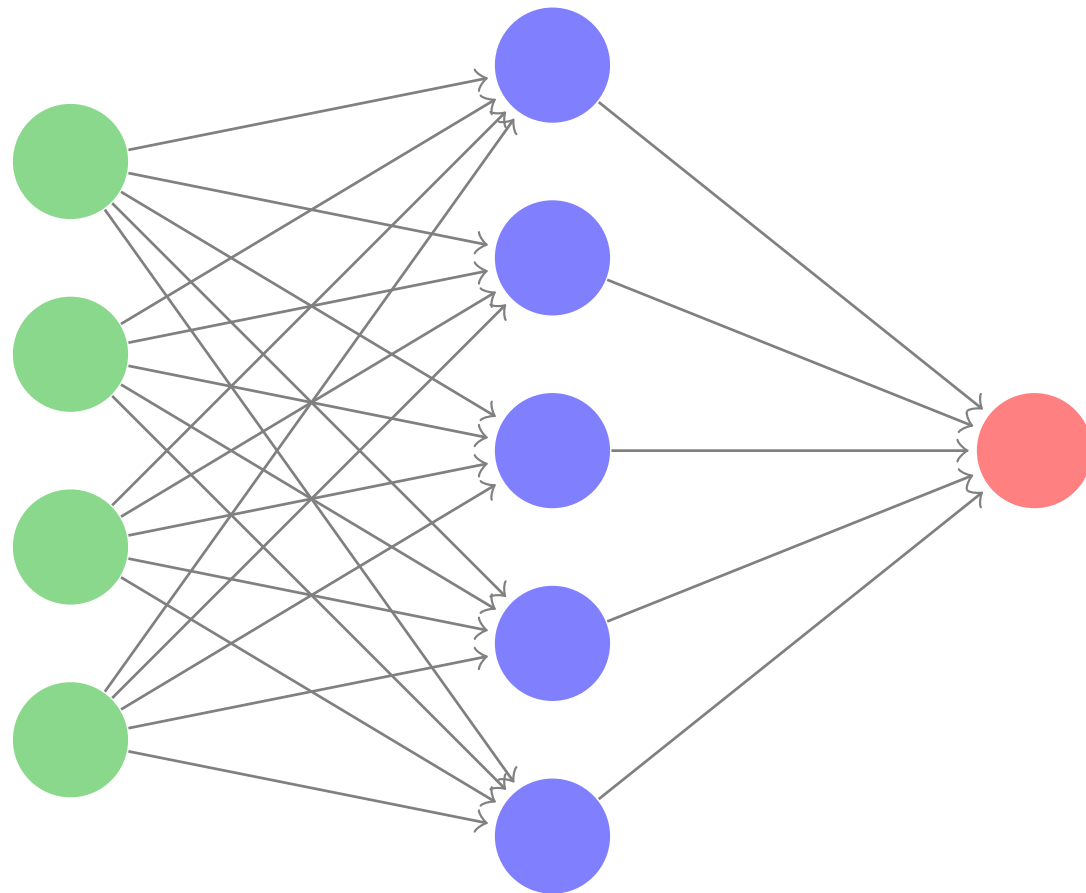
ARTIFICIAL NEURAL NETWORKS

Input
layer

Hidden
layer

Output
layer

- Feed-forward network
- Stochastic gradient descent



(Kim et al. 2016)

ARTIFICIAL NEURAL NETWORKS

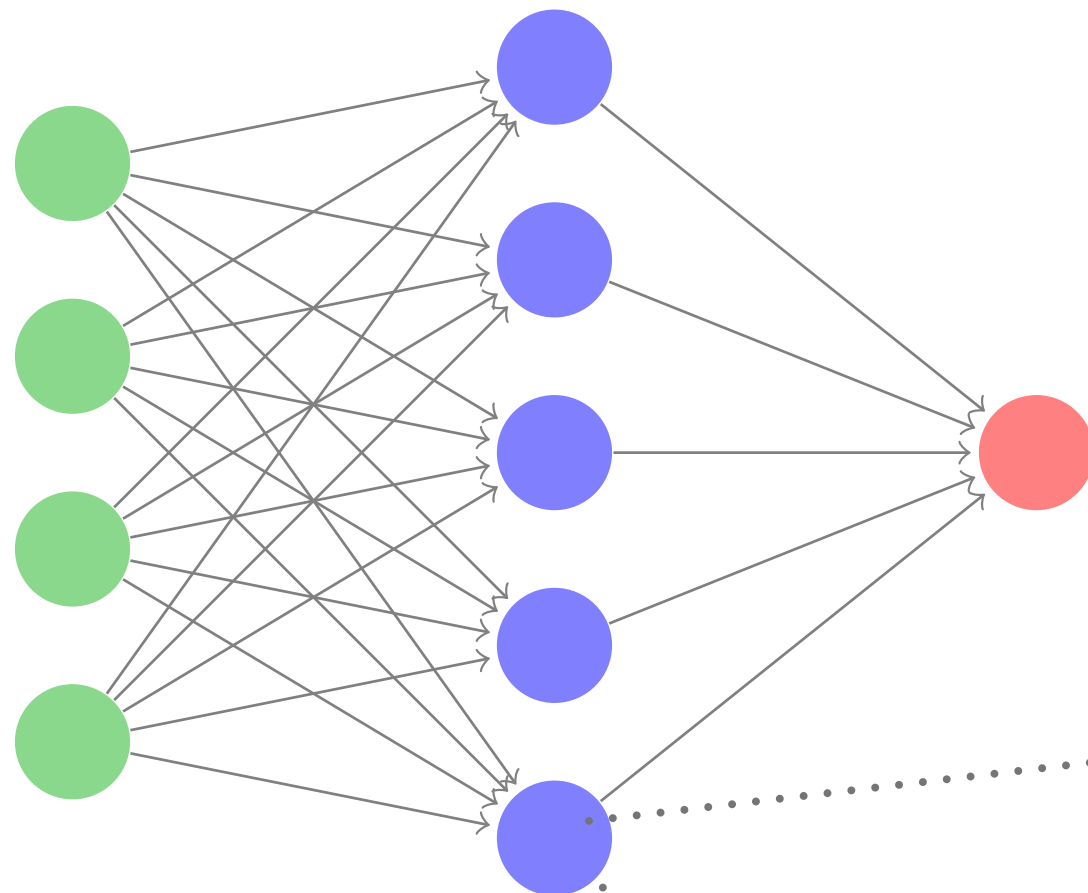
.....

Input
layer

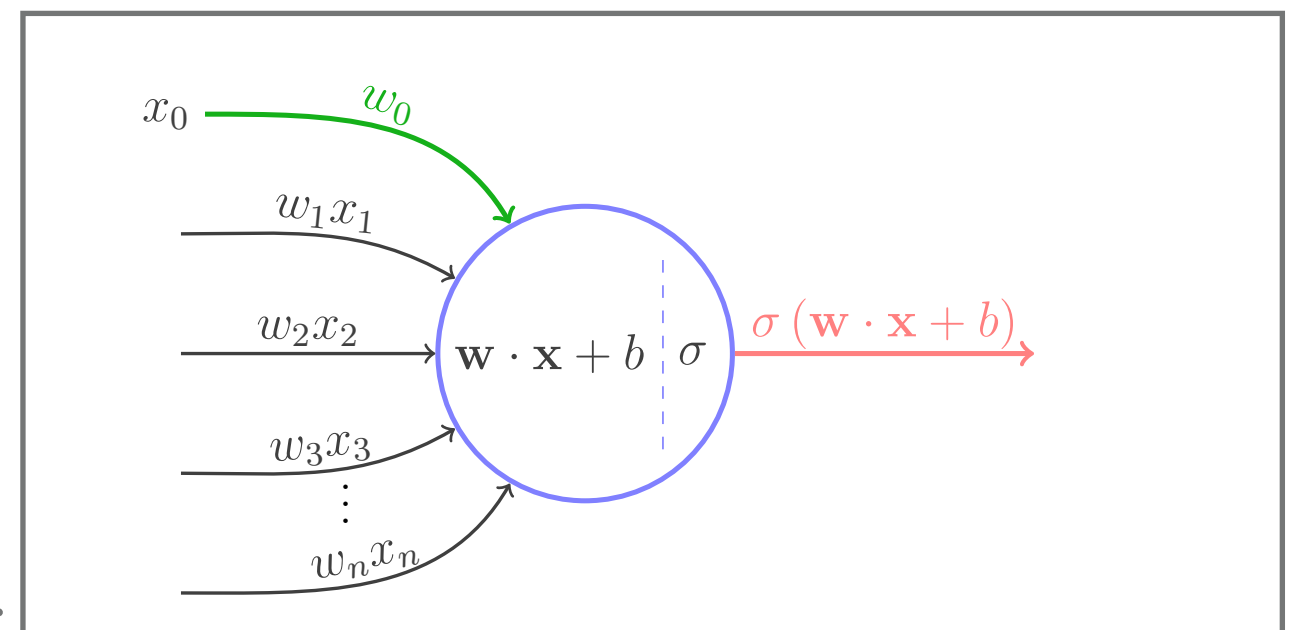
Hidden
layer

Output
layer

- Feed-forward network
- Stochastic gradient descent

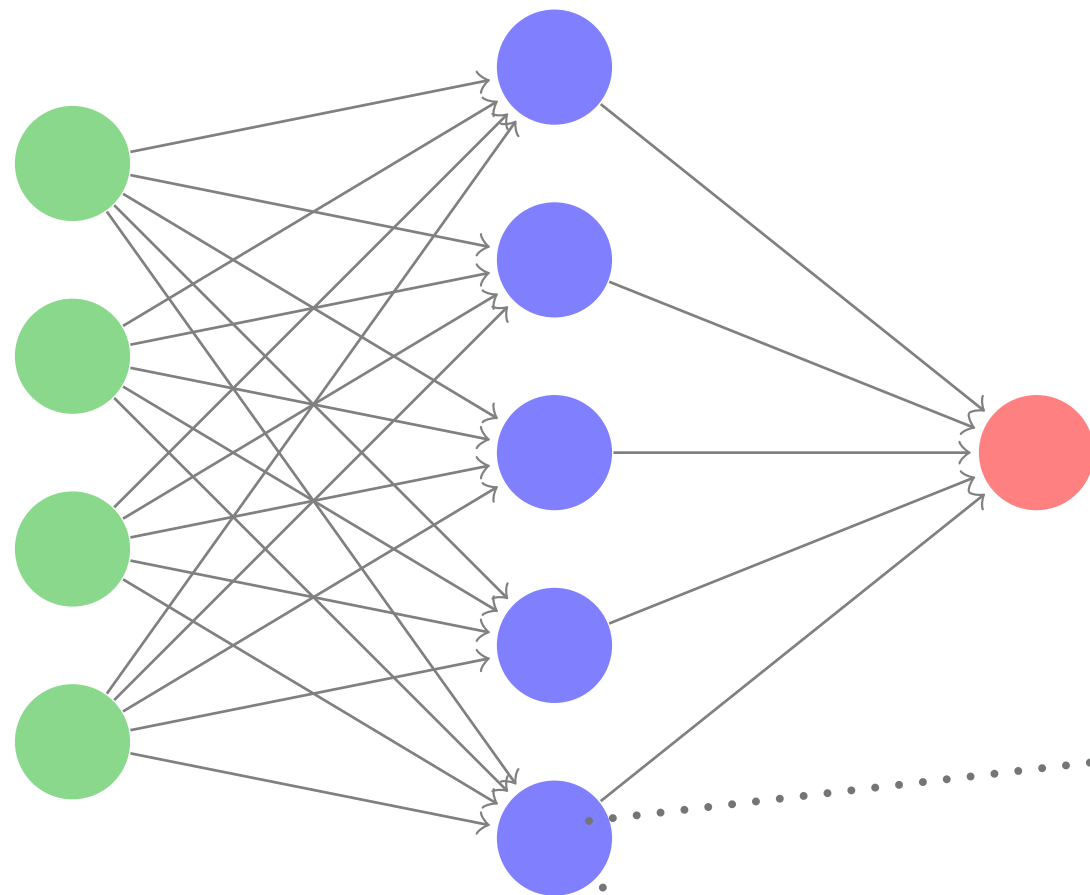


(Kim et al. 2016)



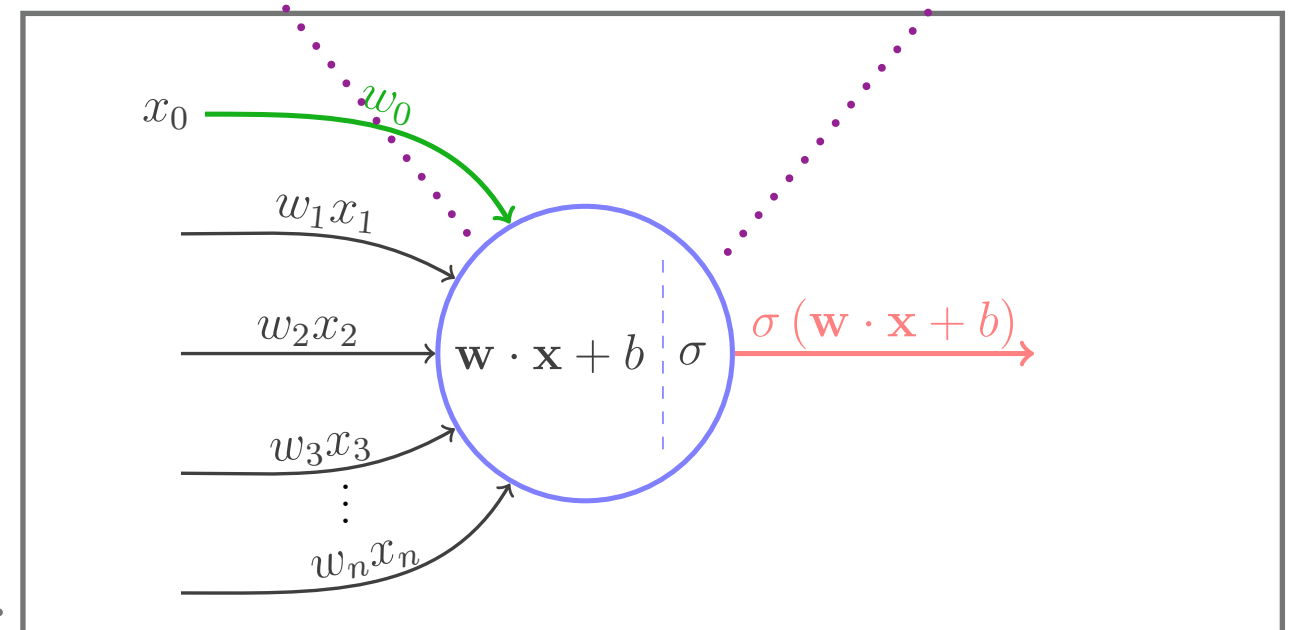
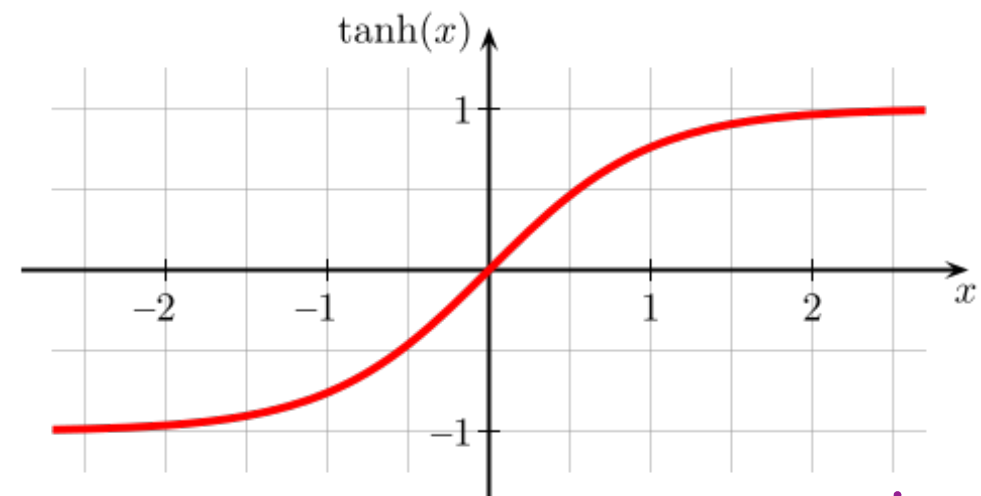
ARTIFICIAL NEURAL NETWORKS

Input layer Hidden layer Output layer

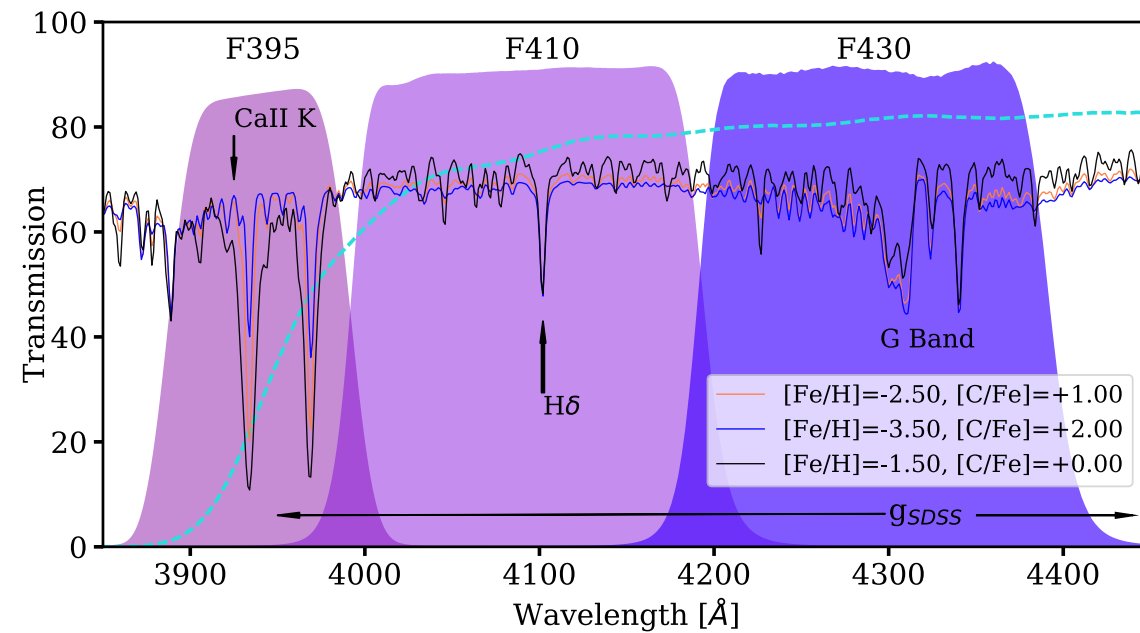


(Kim et al. 2016)

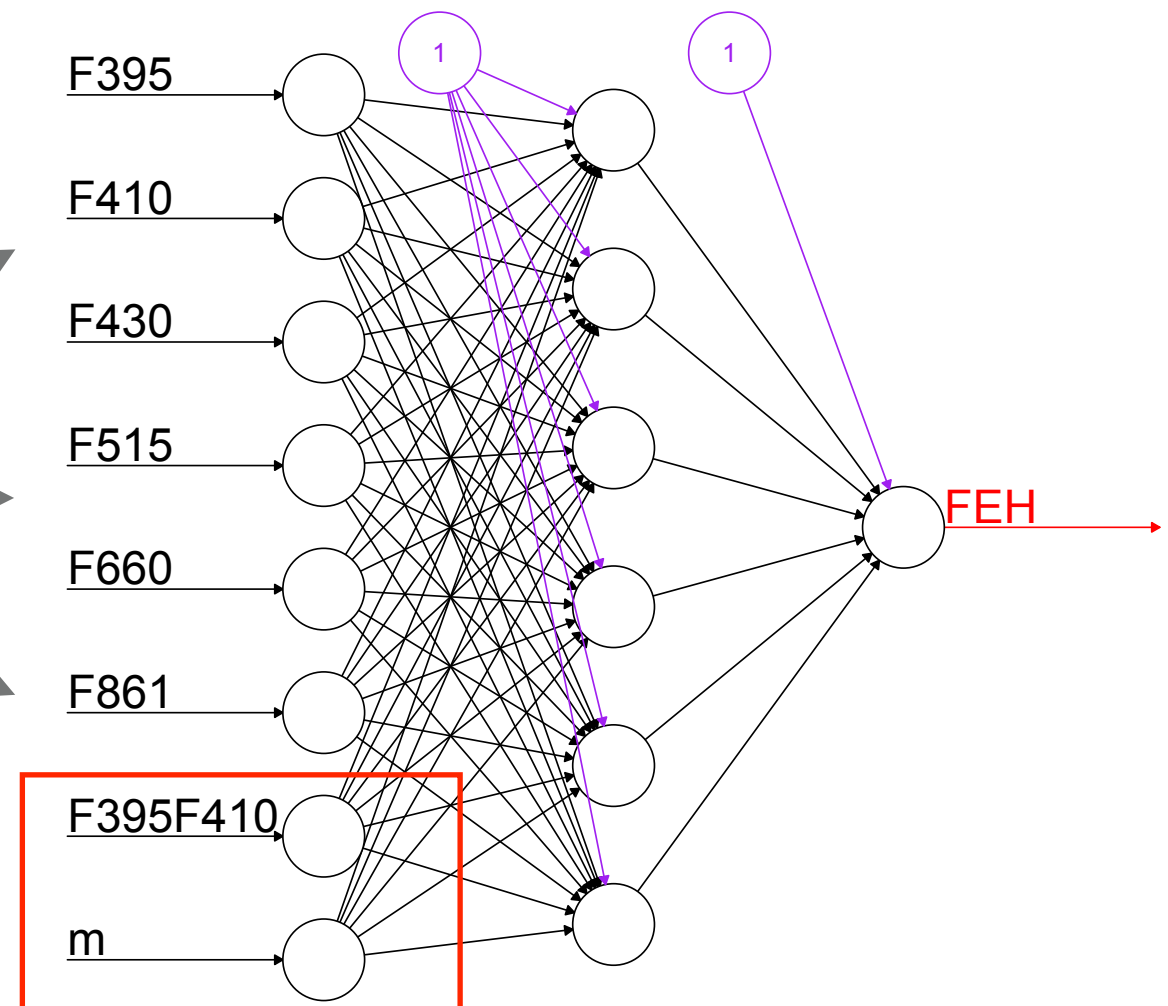
- Feed-forward network
- Stochastic gradient descent



NETWORK OUTLINE



Normalization



SEGUE DATABASE

- SEGUE: Medium-res ($R \sim 2,000$) spectroscopic database
- $\sim 300,000+$ stellar spectra
- Train networks using synthetic magnitudes
- Calibrate magnitudes to J-PLUS Early Data Release

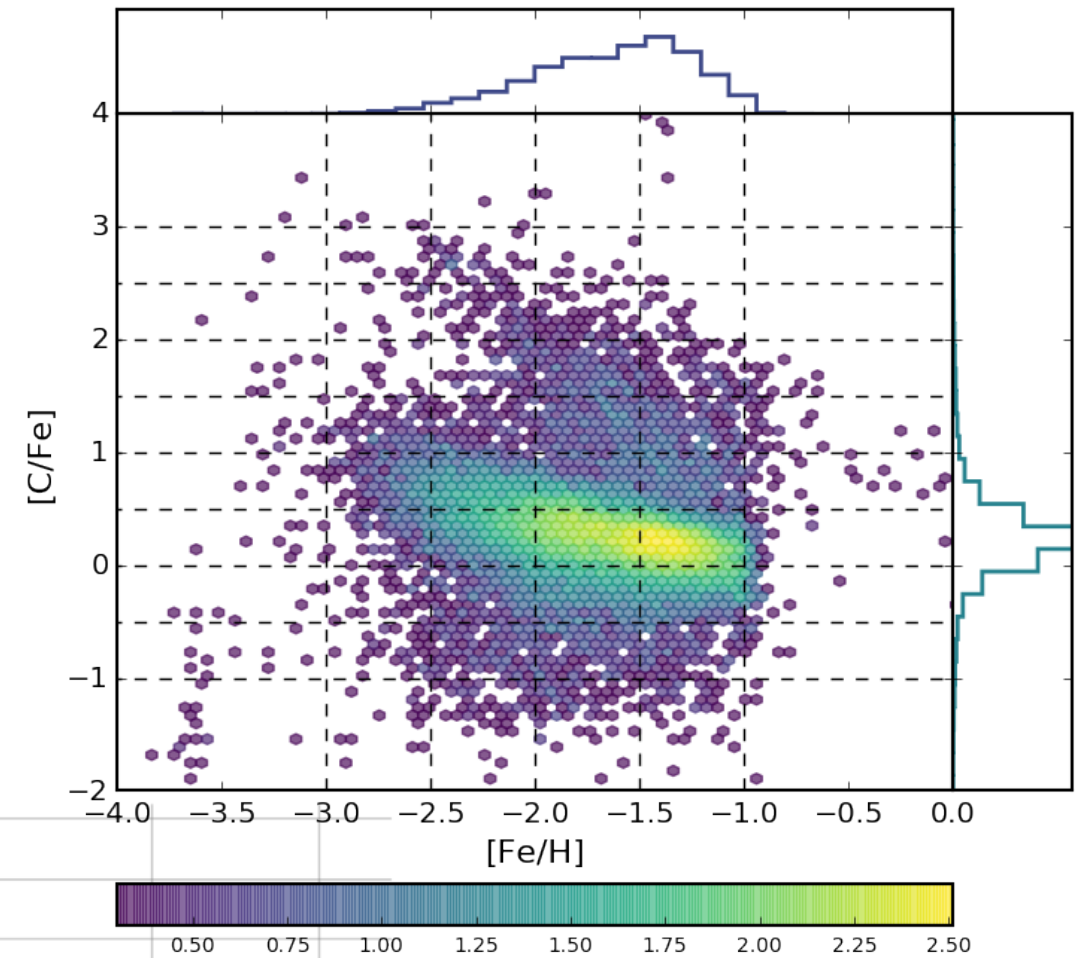
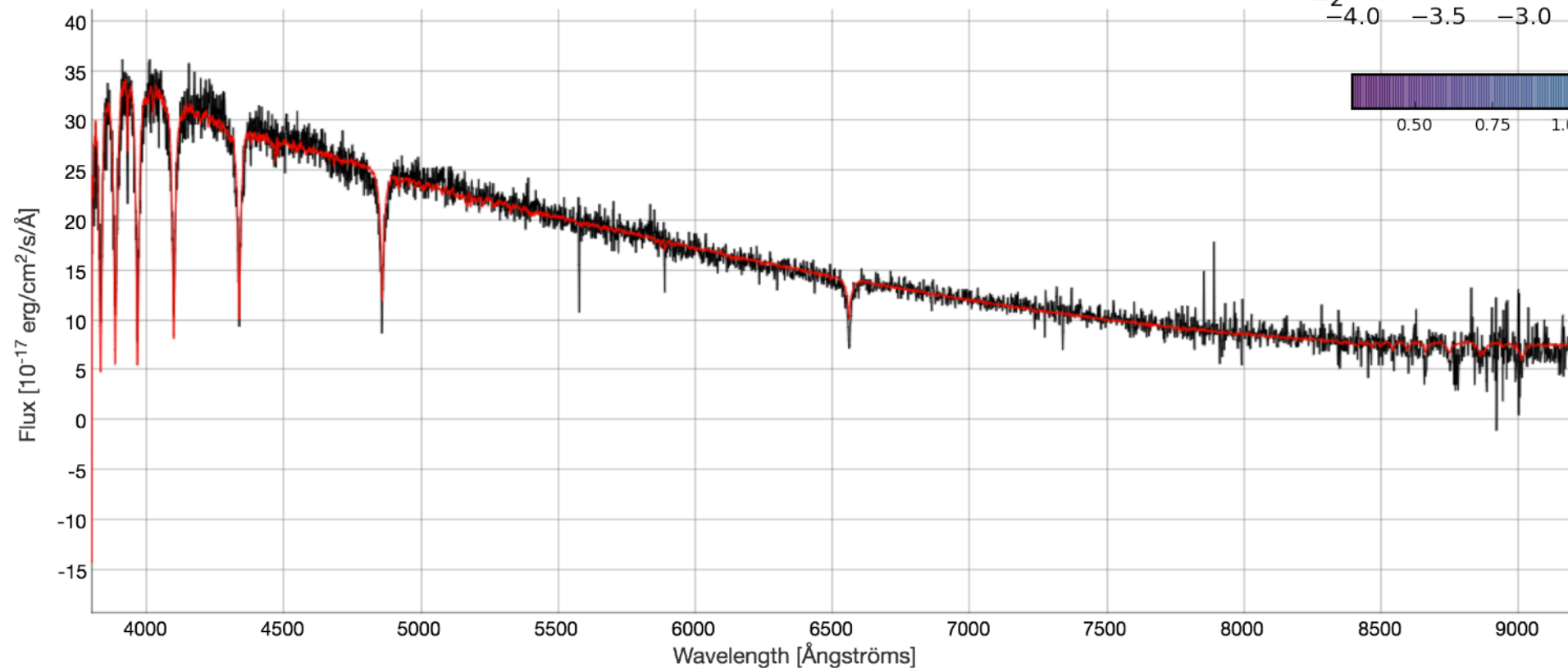
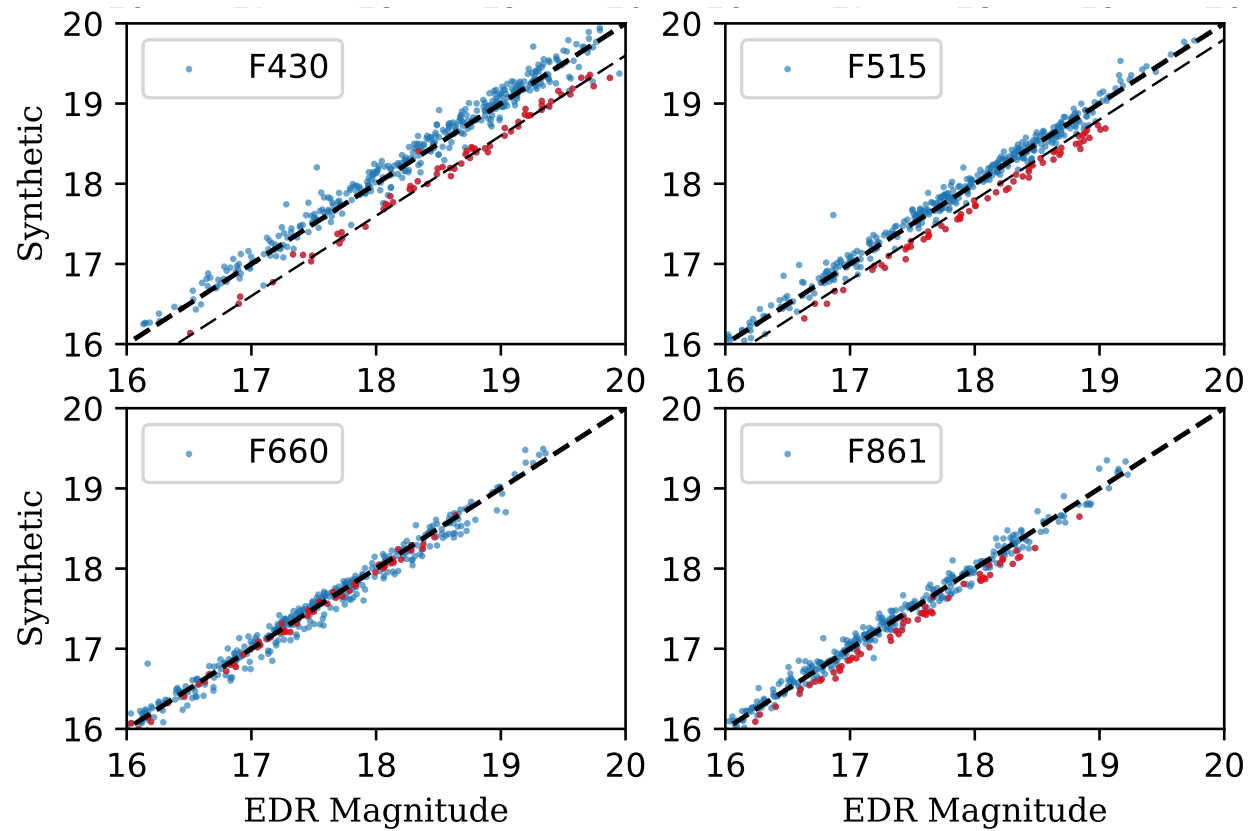


Plate: 0829, MJD: 52296, Fiber: 0192



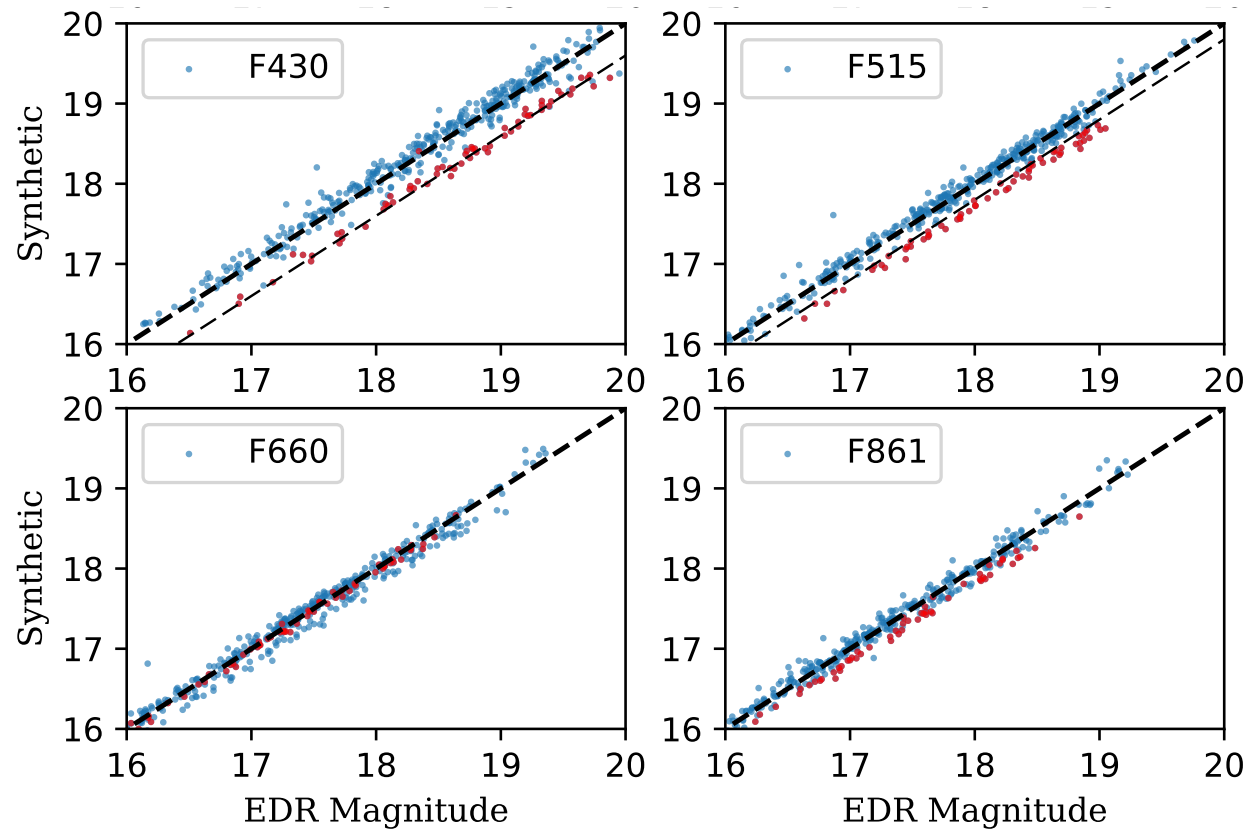
SYNTHETIC MAGNITUDE CALIBRATION WITH EDR



.. as of June 27th

- Synthetic magnitude calibration possible with EDR cross-match (~ 1000 stars)
- Enabled identification of potentially erroneous plates

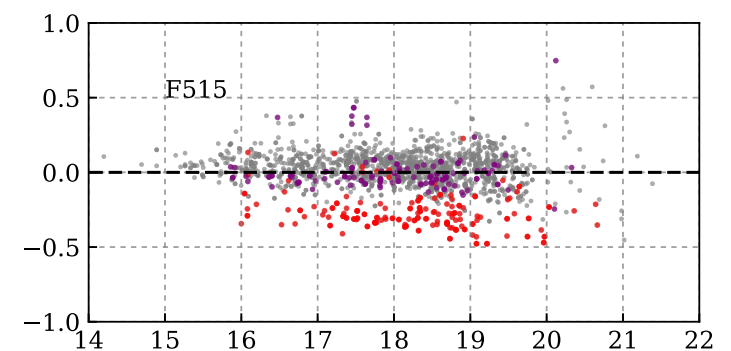
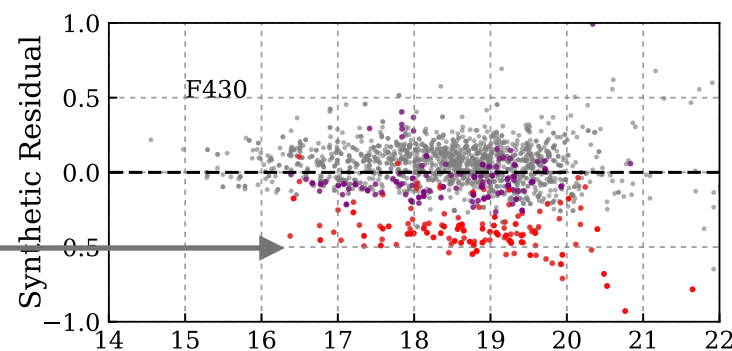
SYNTHETIC MAGNITUDE CALIBRATION WITH EDR



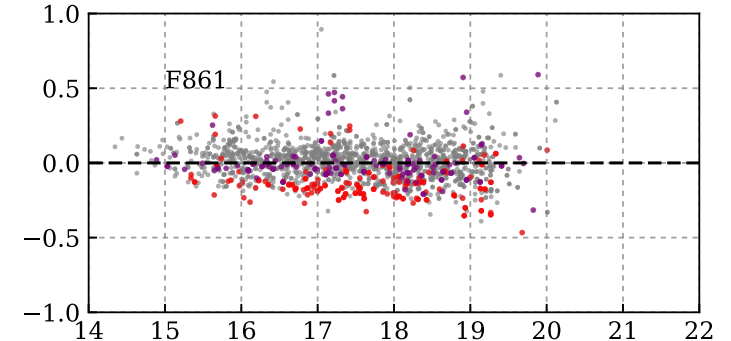
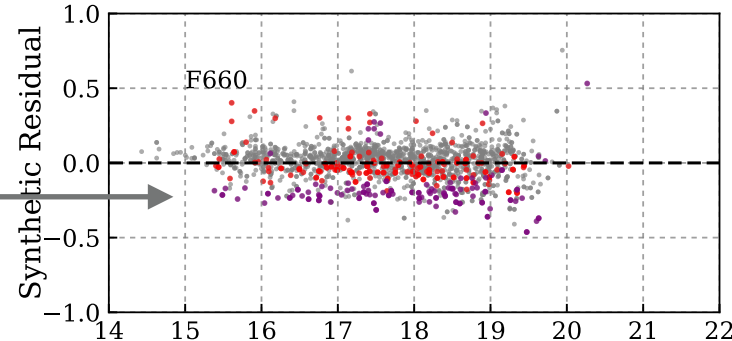
- Synthetic magnitude calibration possible with EDR cross-match (~ 1000 stars)
- Enabled identification of potentially erroneous plates

.. as of June 27th

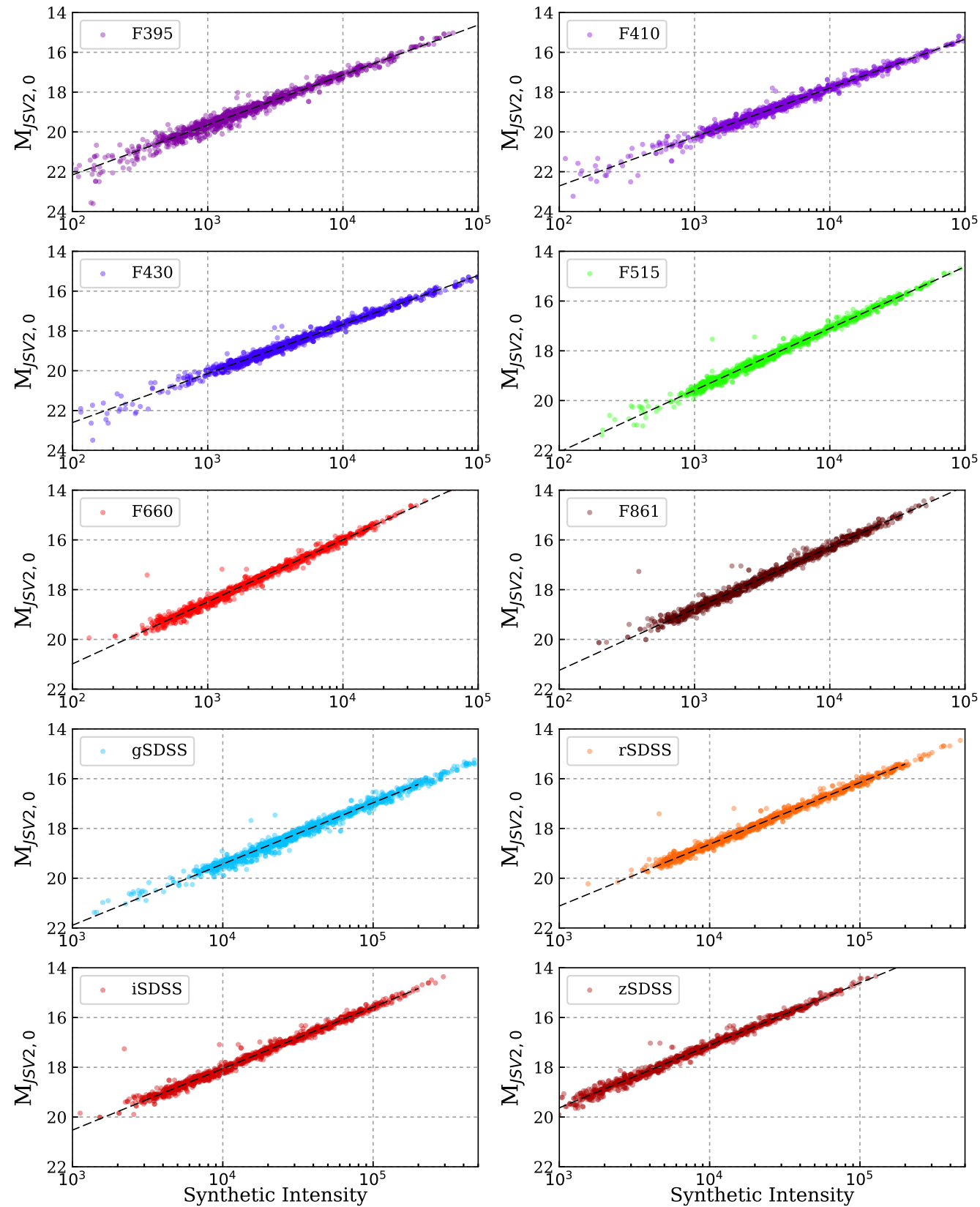
Tile: 8461



Tile: 8497



CALIBRATIONS



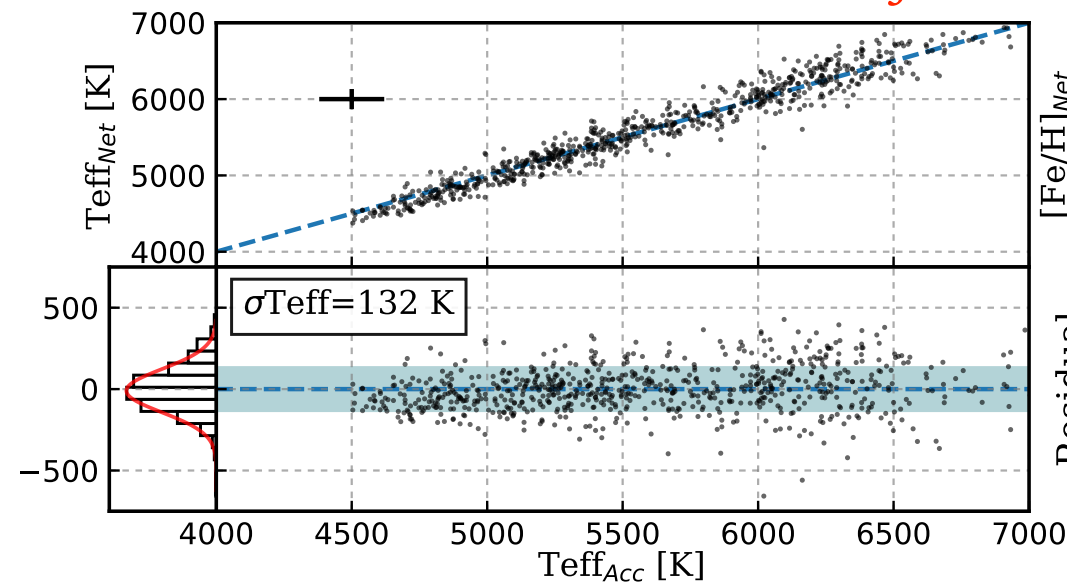
± 0.15 mags

PRELIMINARY RESULTS

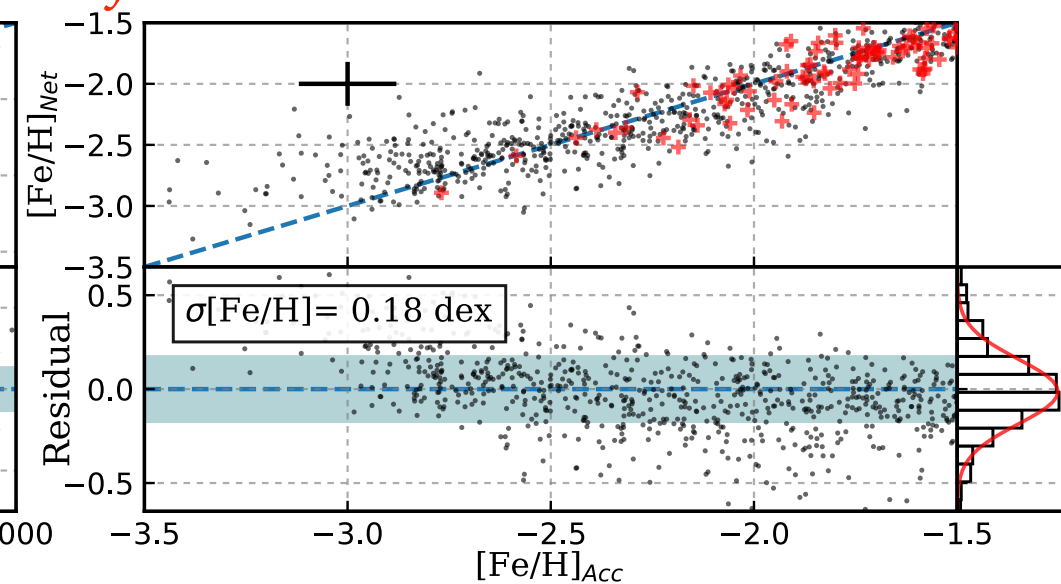
.....

Temperature

With J-PLUS Synthetic EDR



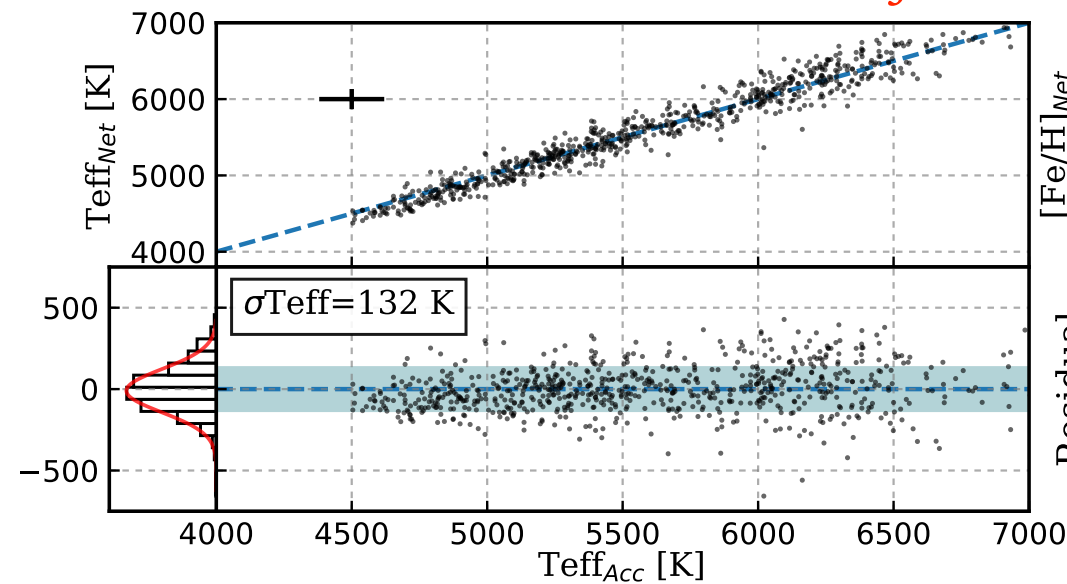
Metallicity



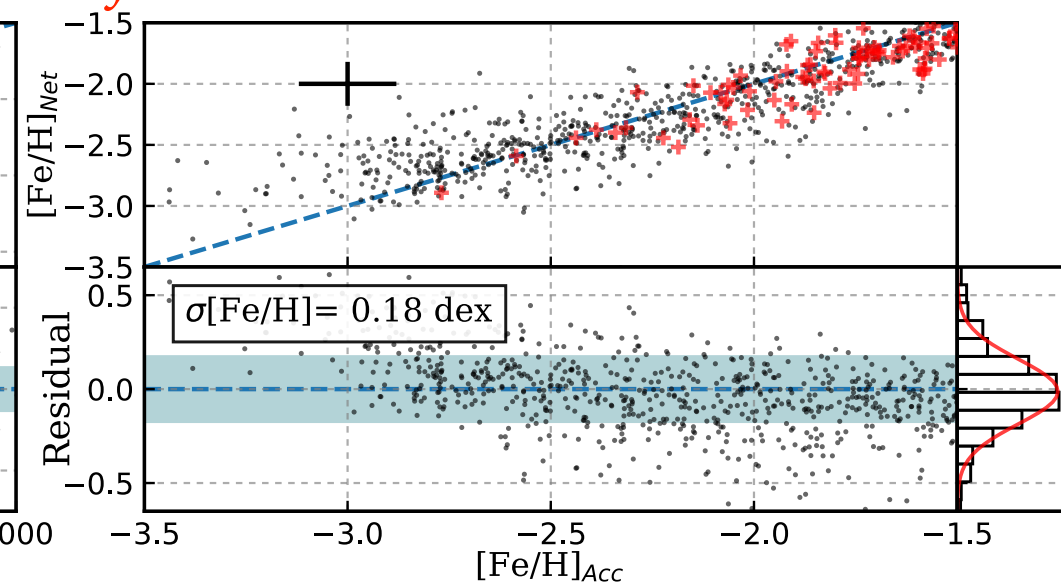
PRELIMINARY RESULTS

Temperature

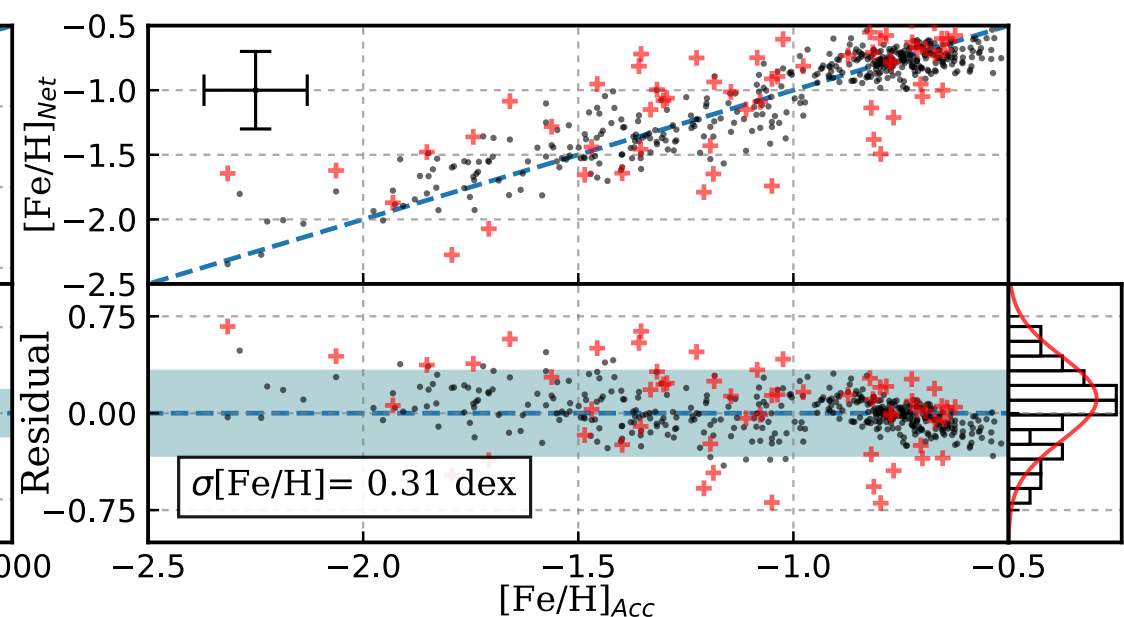
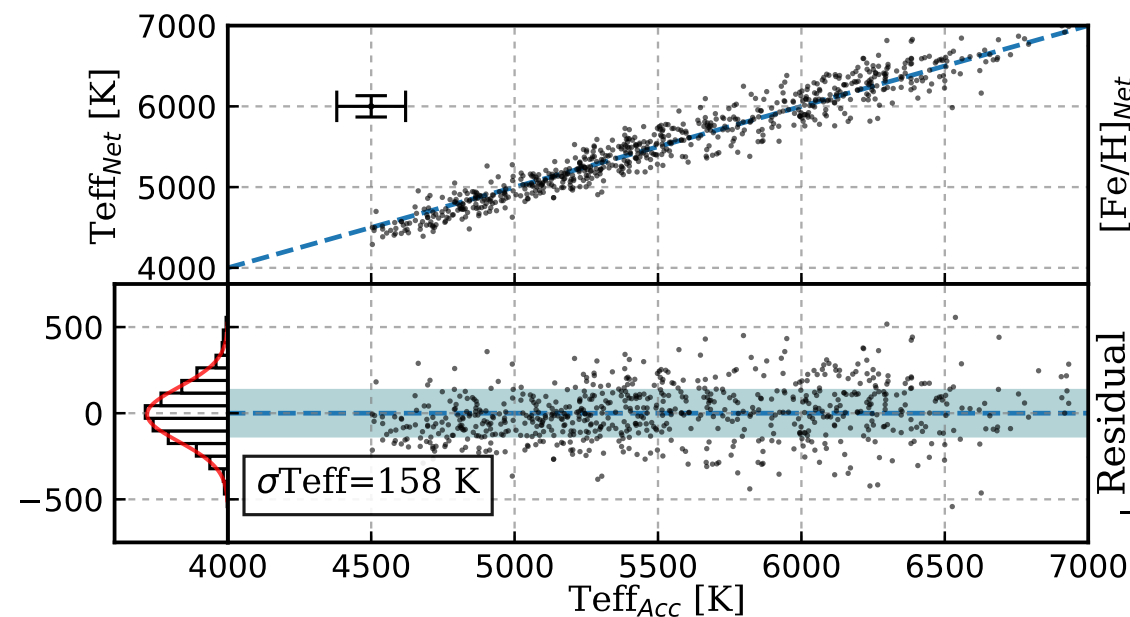
With J-PLUS Synthetic EDR



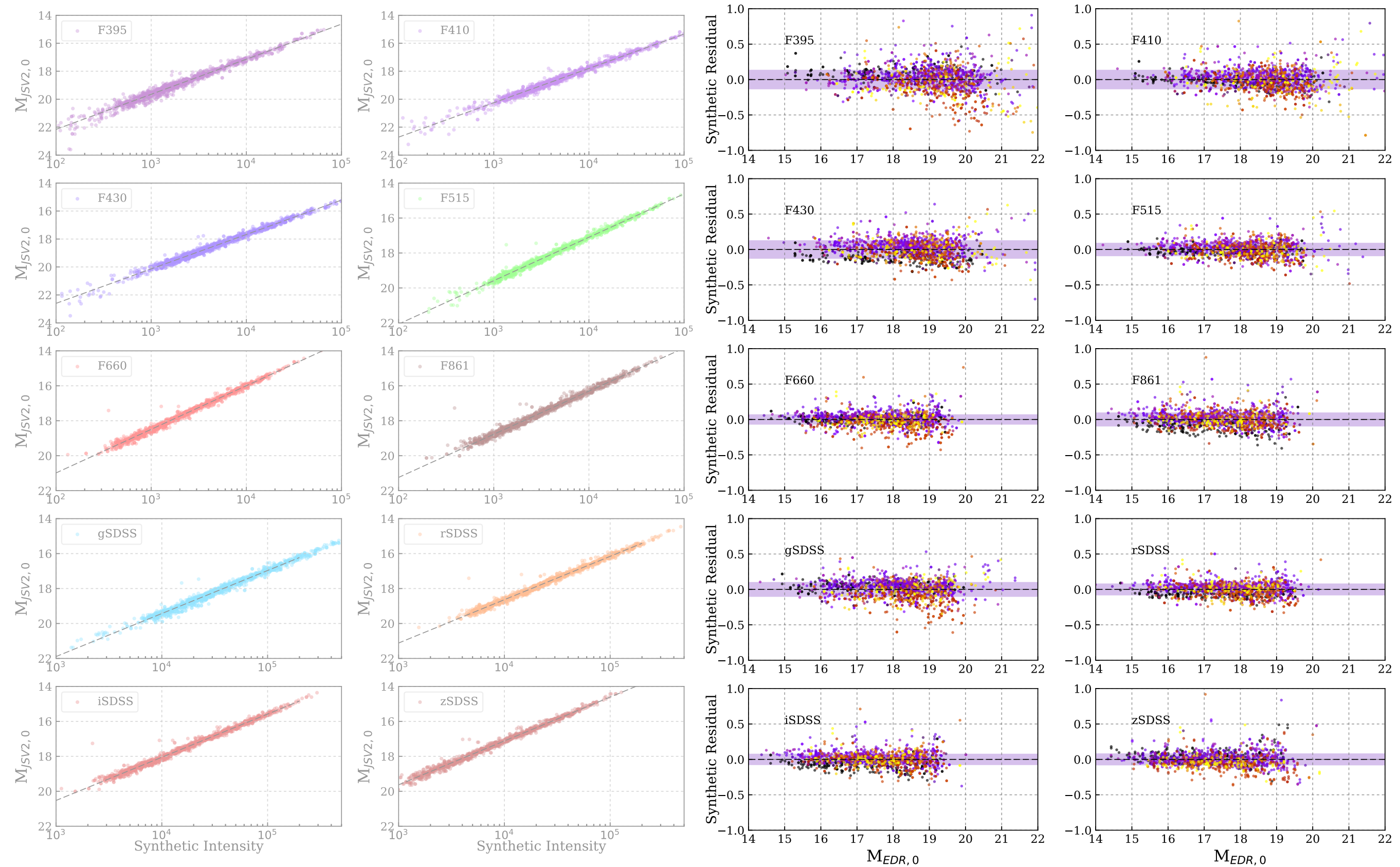
Metallicity



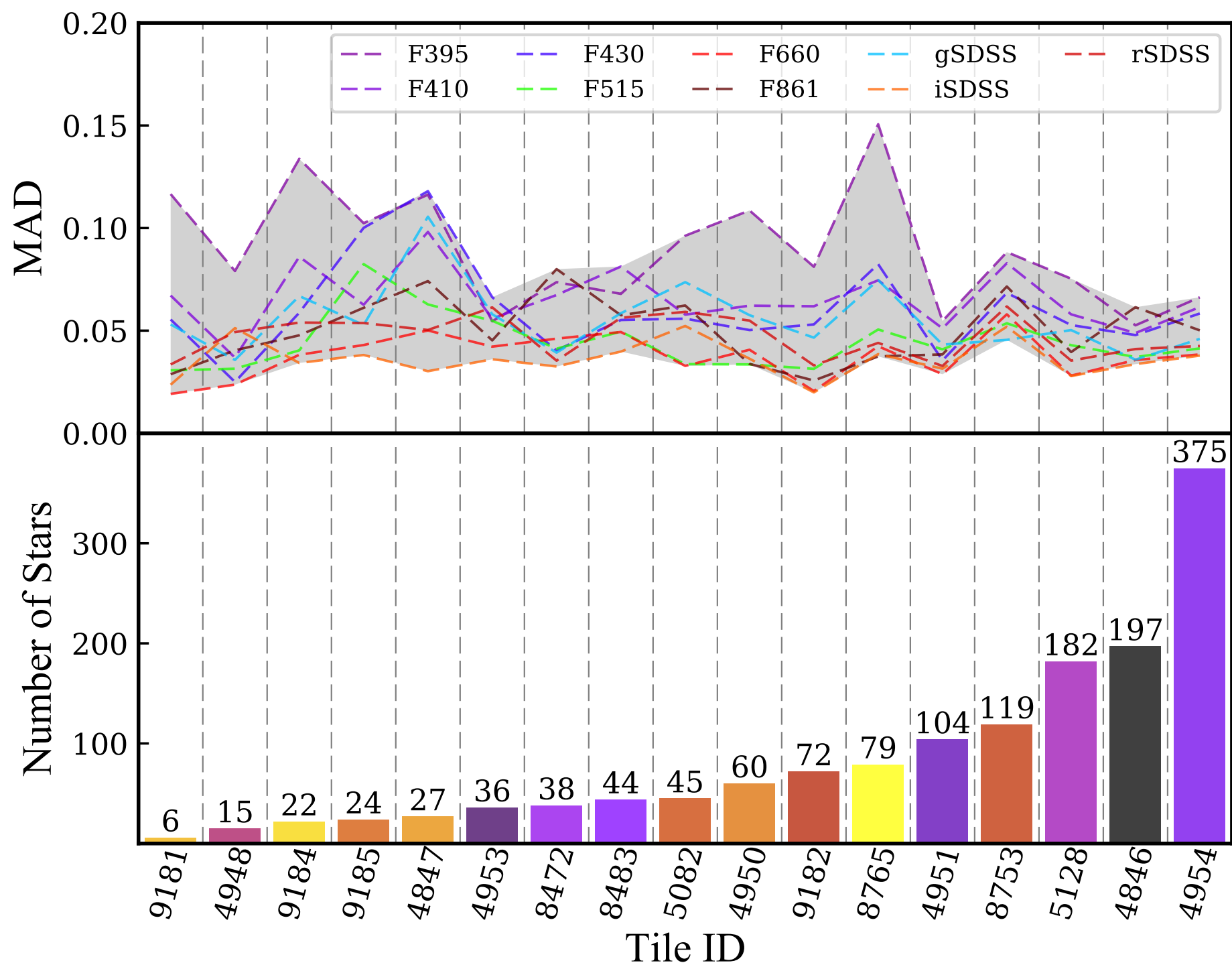
With J-PLUS EDR



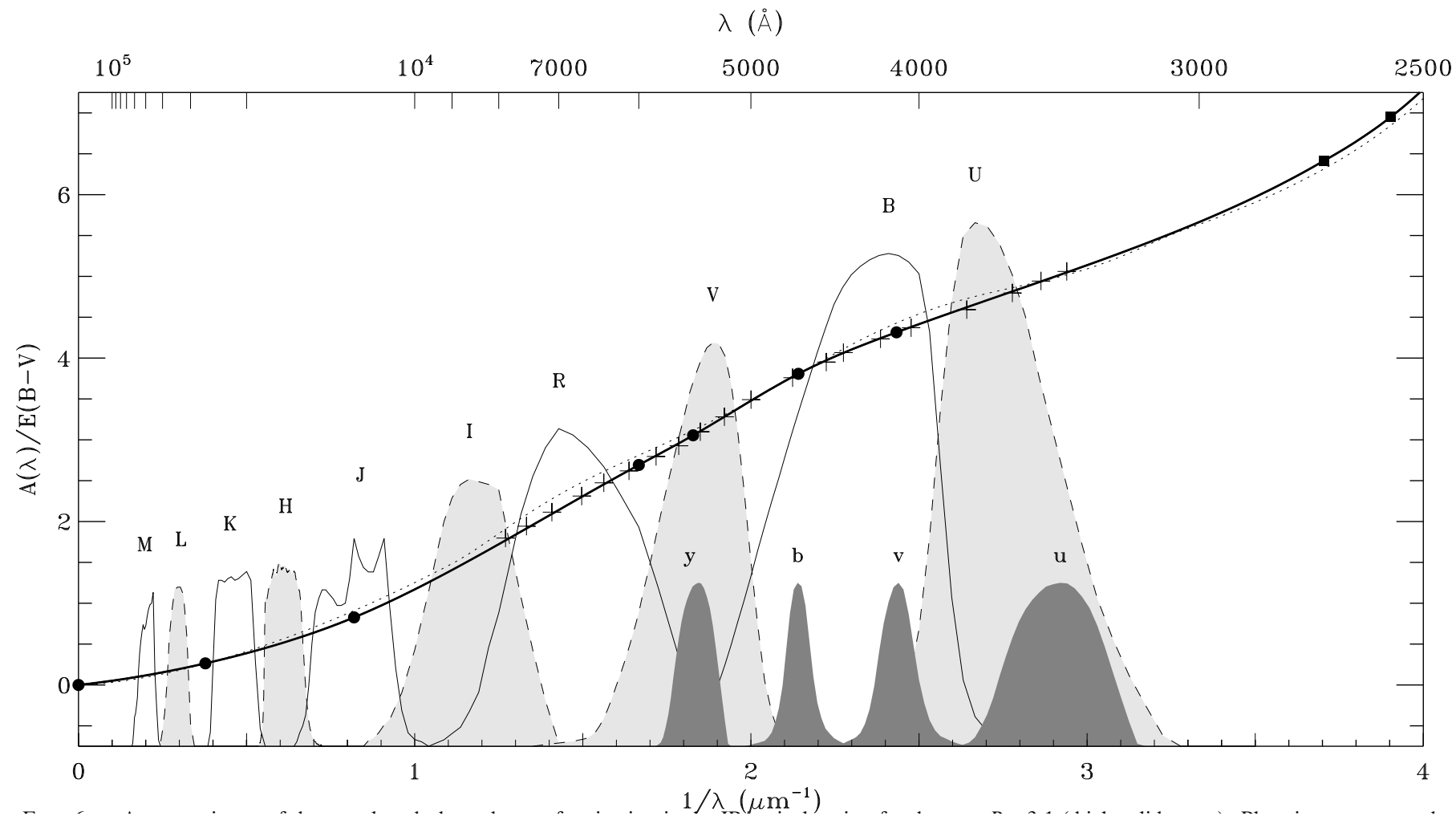
CALIBRATIONS



CHALLENGES: TILE DEVIATIONS

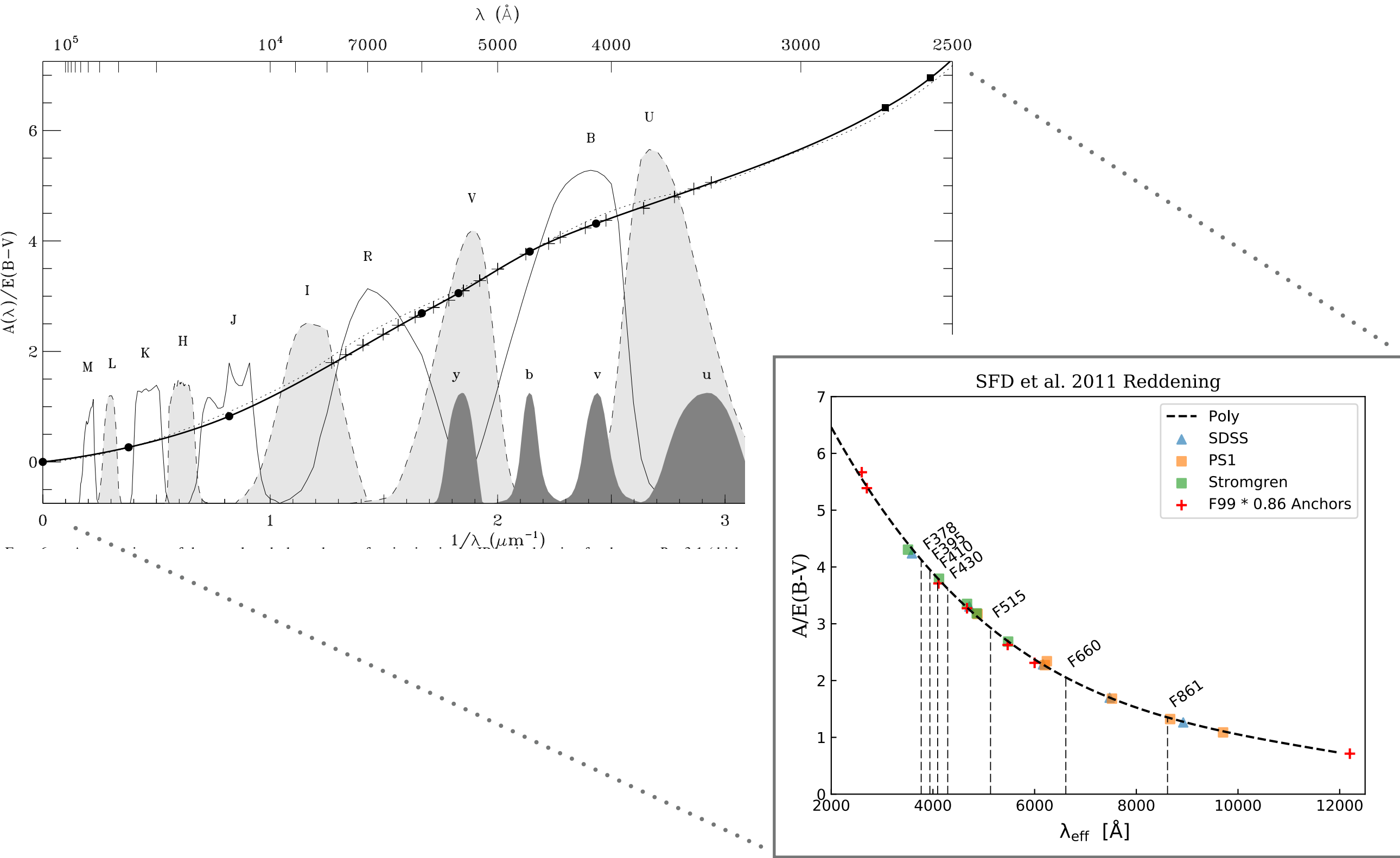


CHALLENGES: INTERSTELLAR EXTINCTION

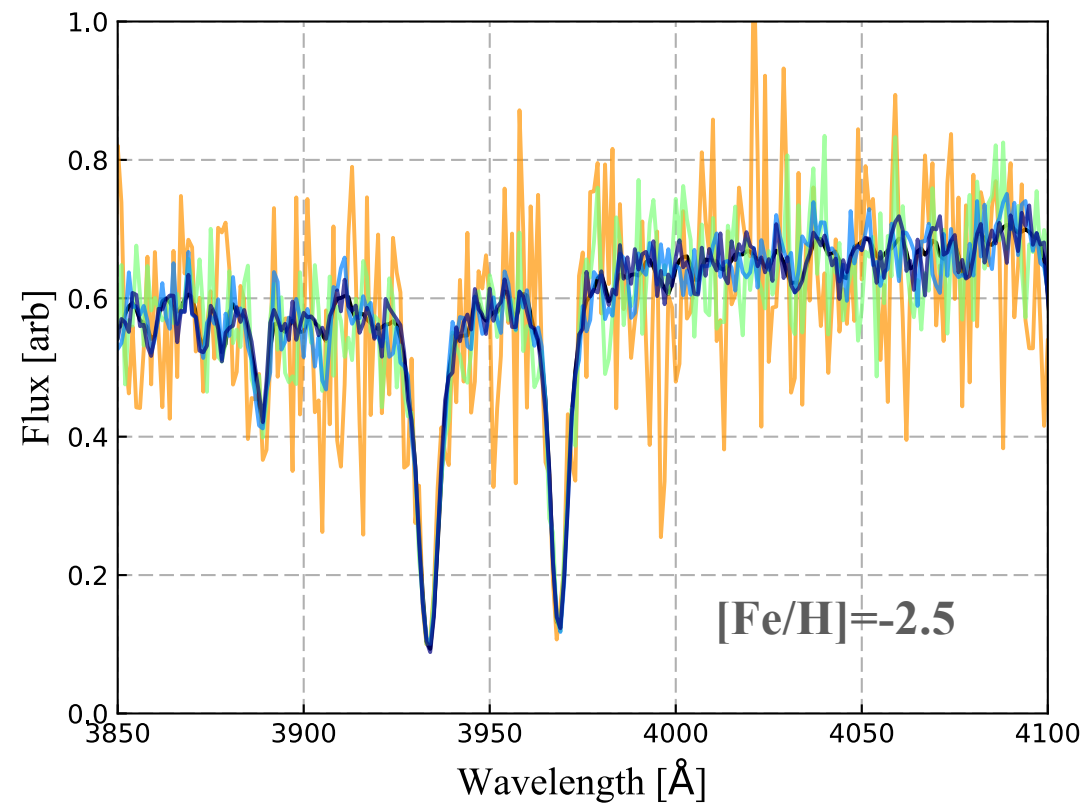


- We know interstellar extinction is a problem, particularly for UV filters
- Dust mapping - (Fitzpatrick et al. 1998)
- Recent recalibration with (Schlafly et al. 2011)

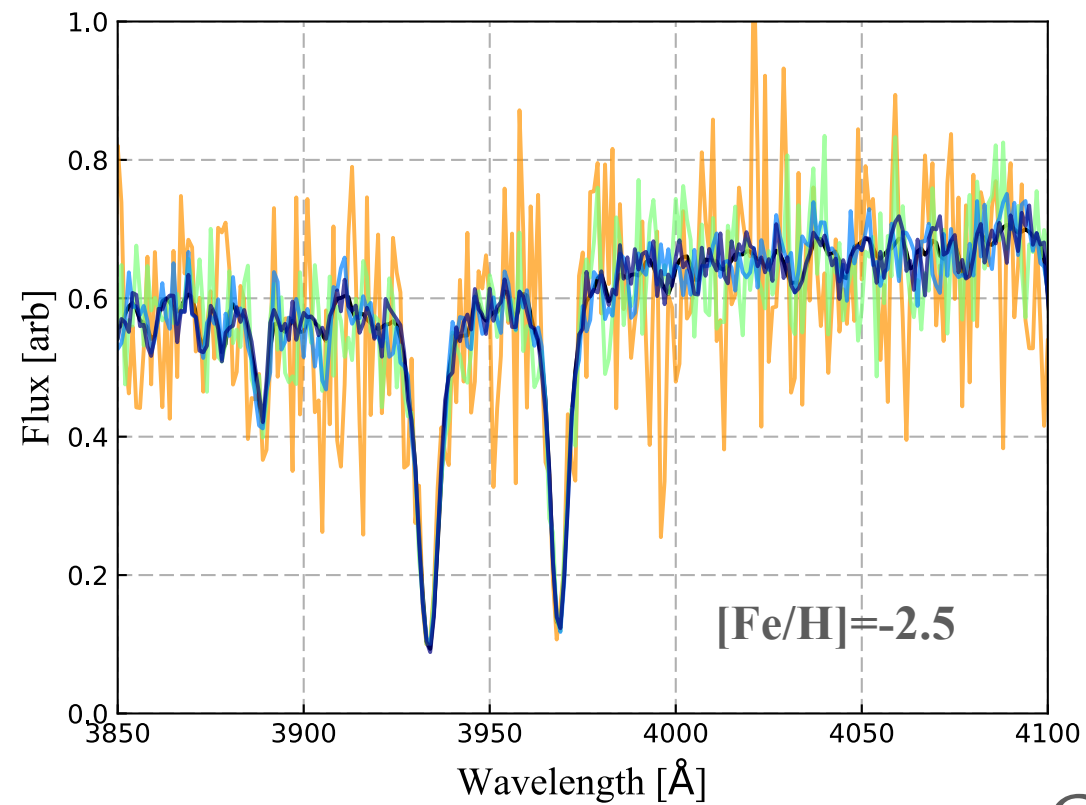
CHALLENGES: INTERSTELLAR EXTINCTION



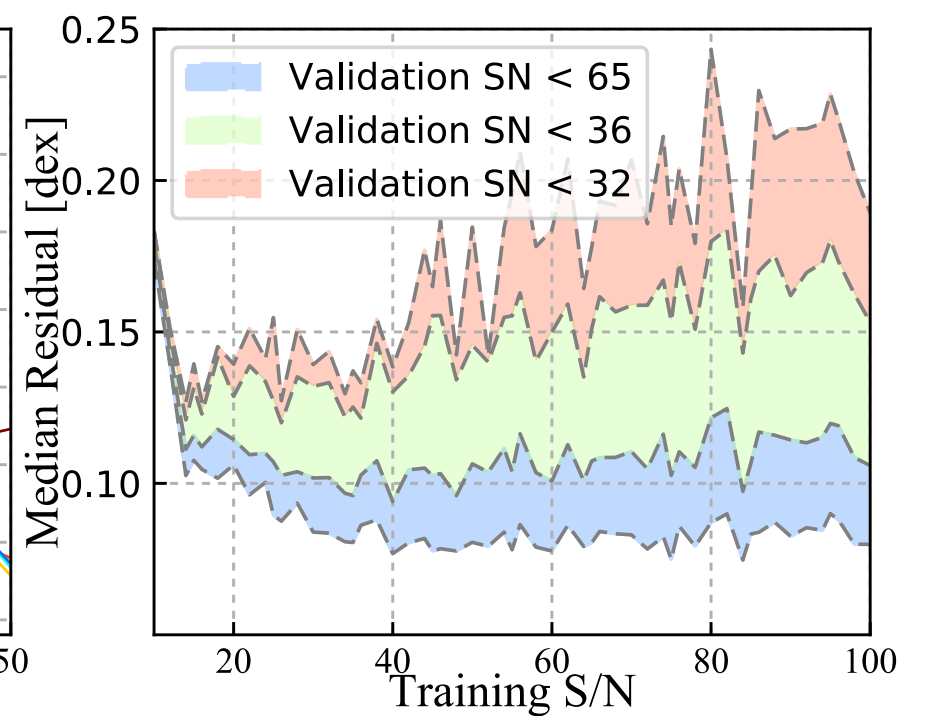
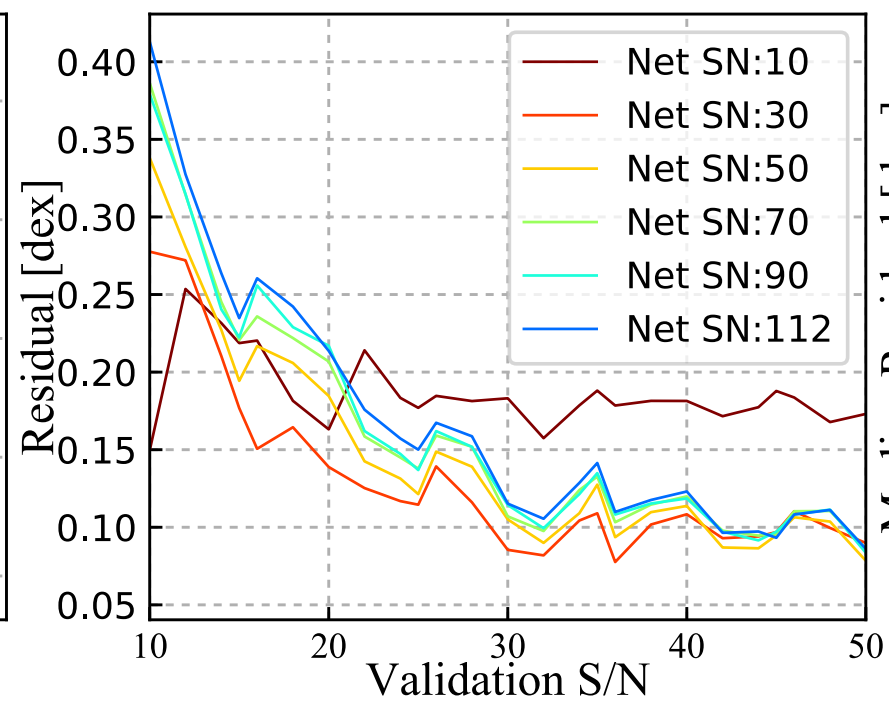
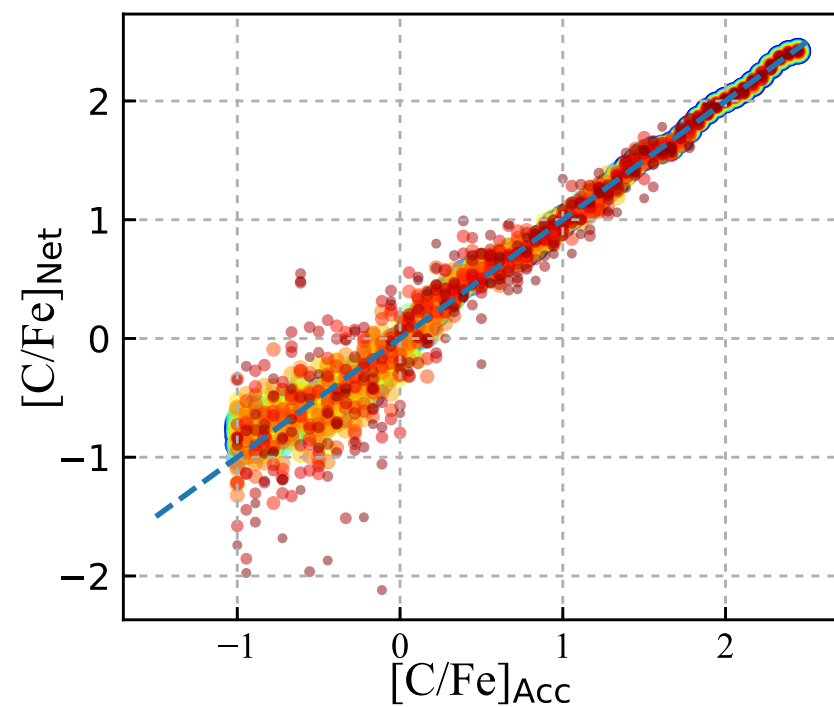
CHALLENGES: NOISE



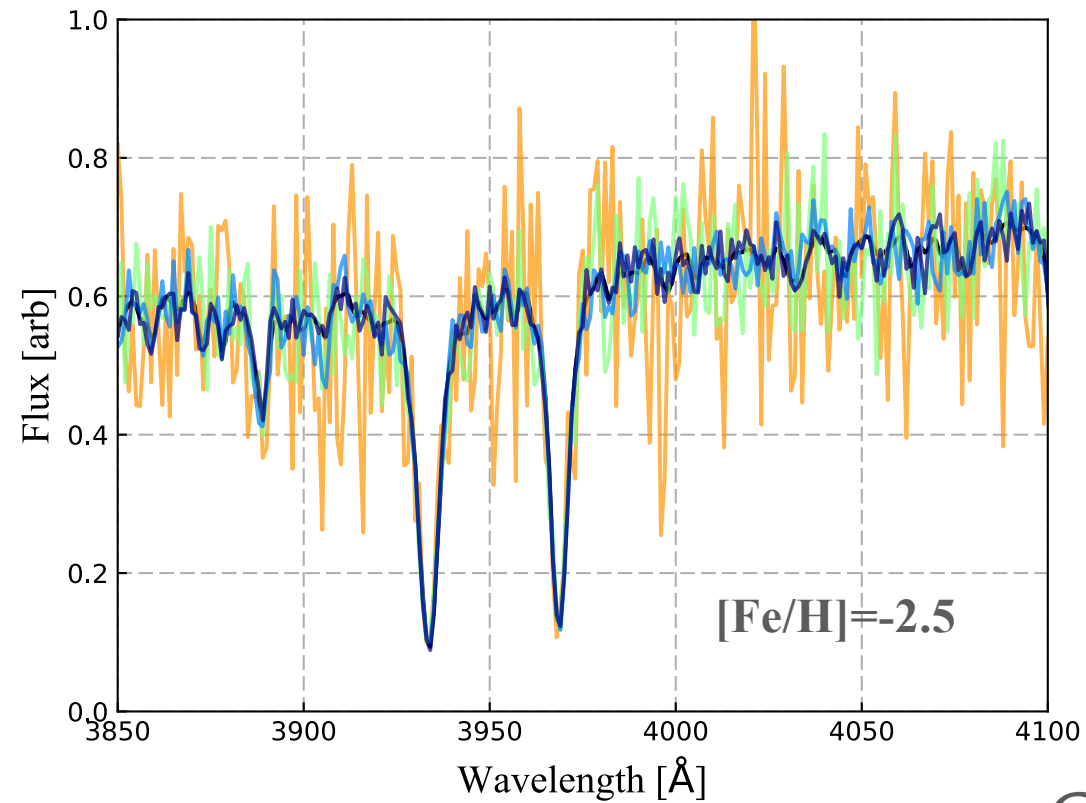
CHALLENGES: NOISE



Carbon (Synthetic)

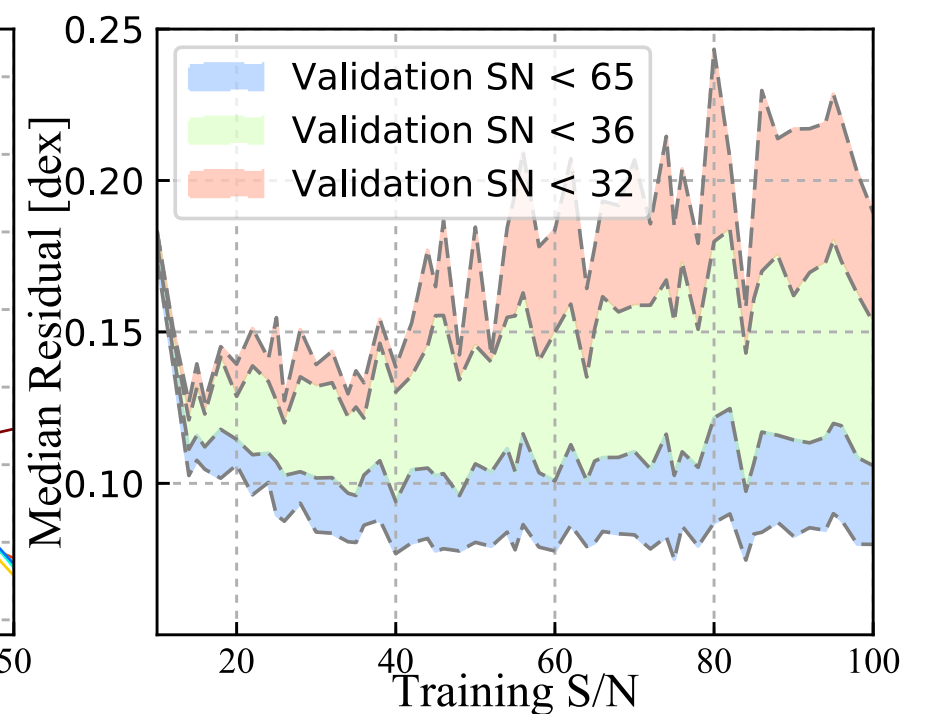
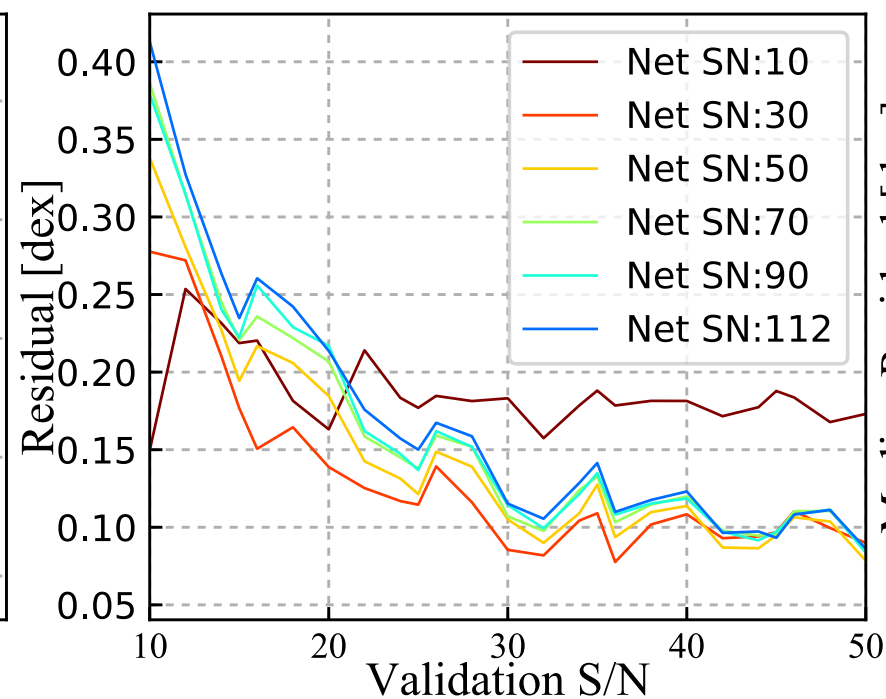
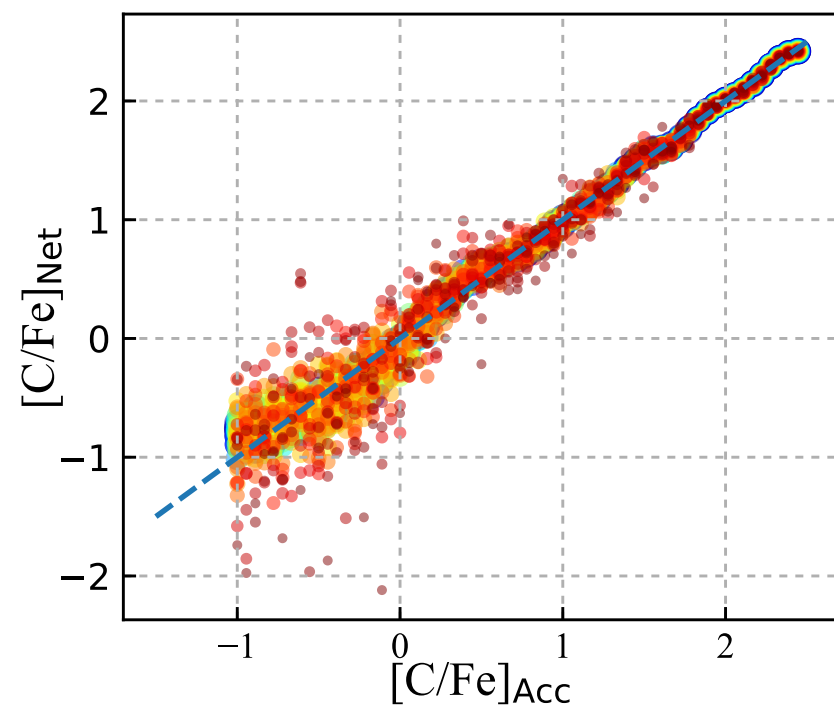


CHALLENGES: NOISE

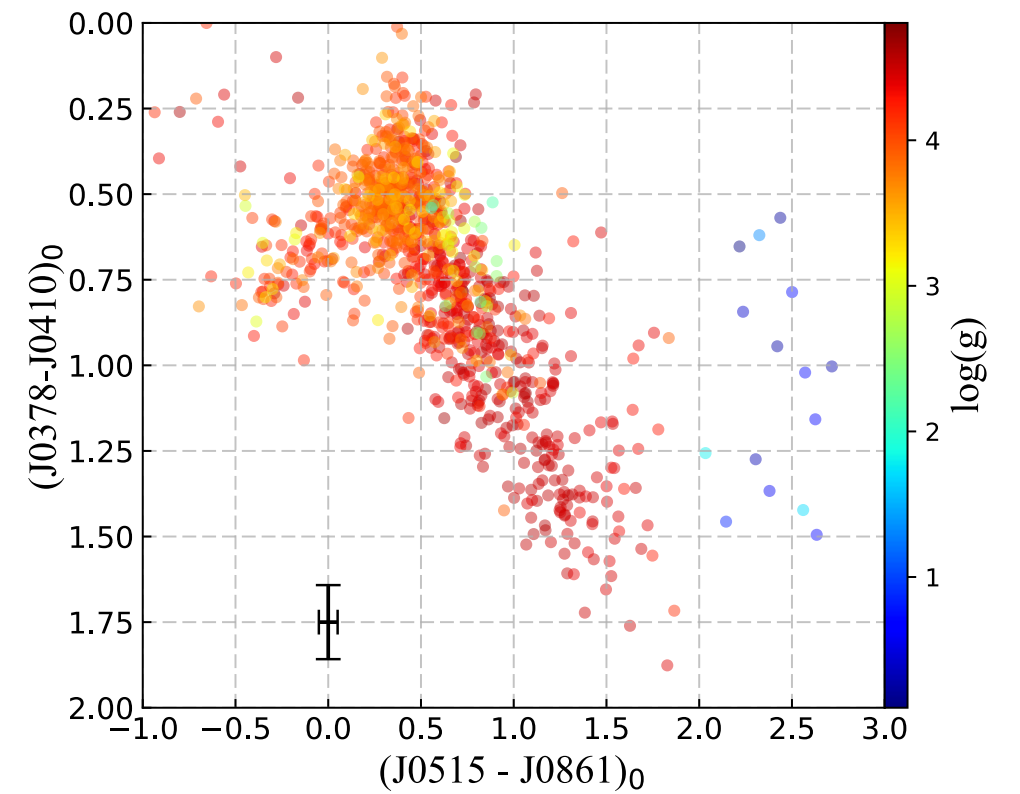
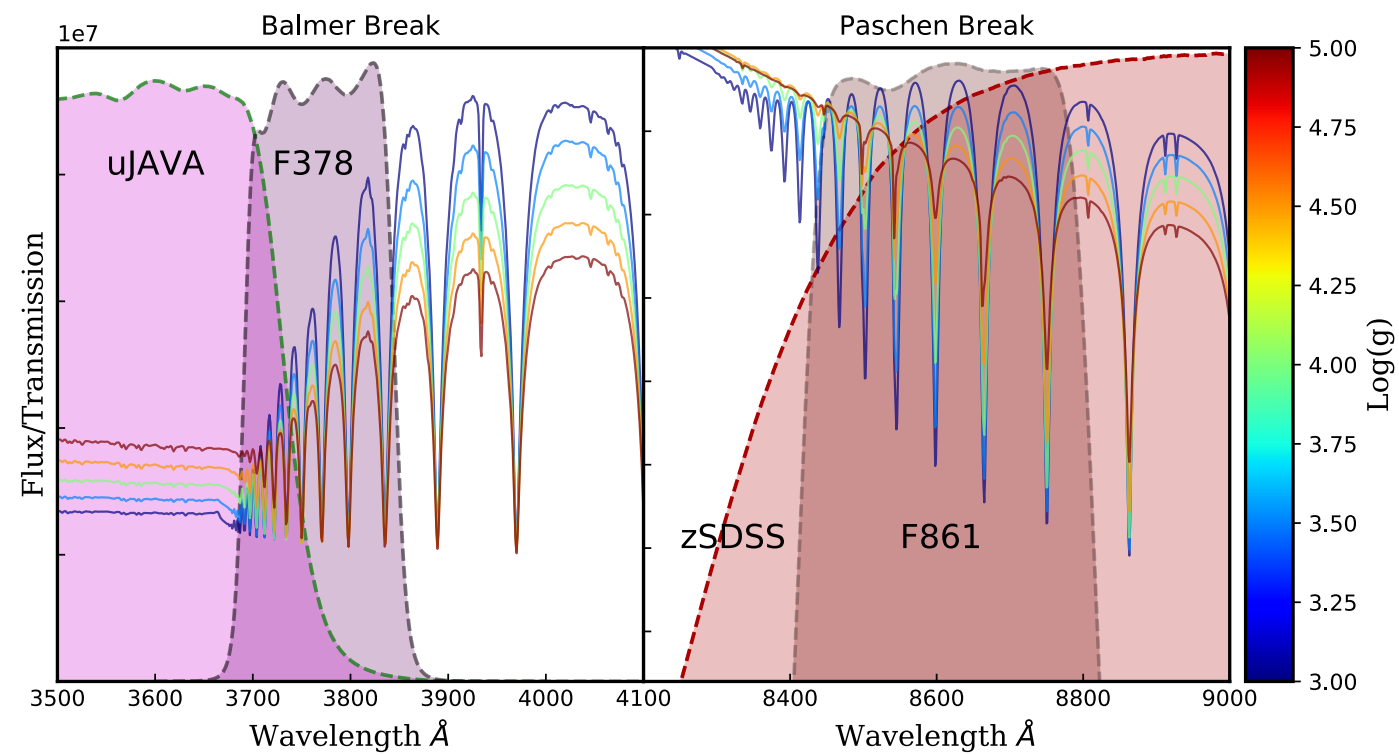


- Introducing noise during network training increases performance with low S/N inputs

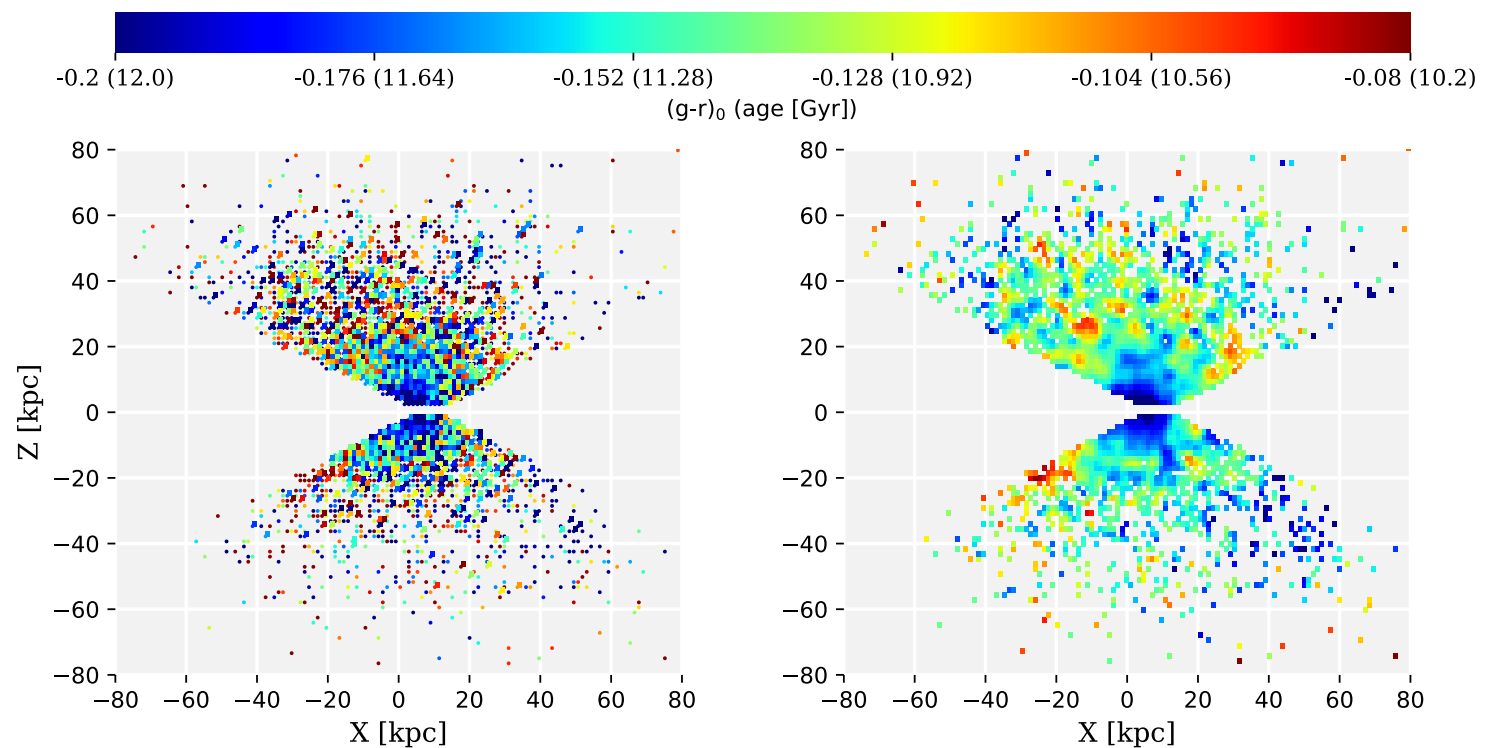
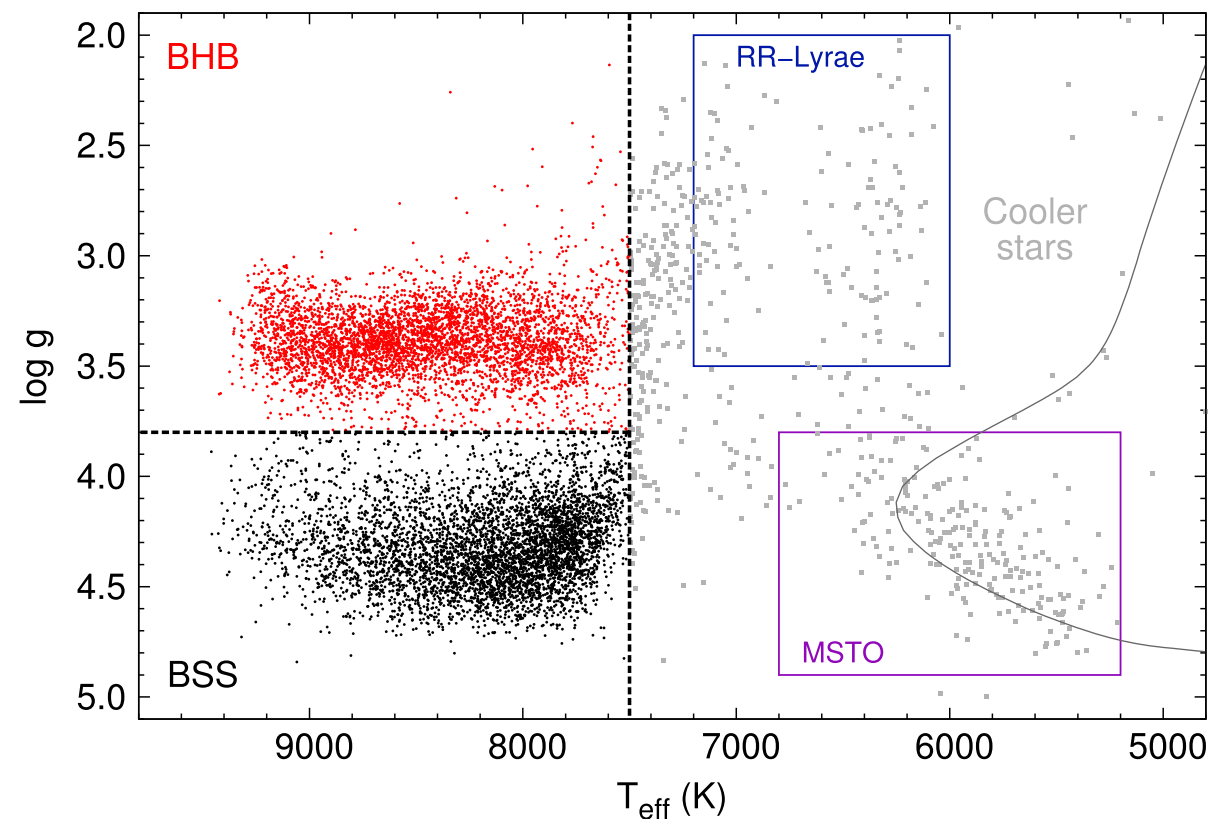
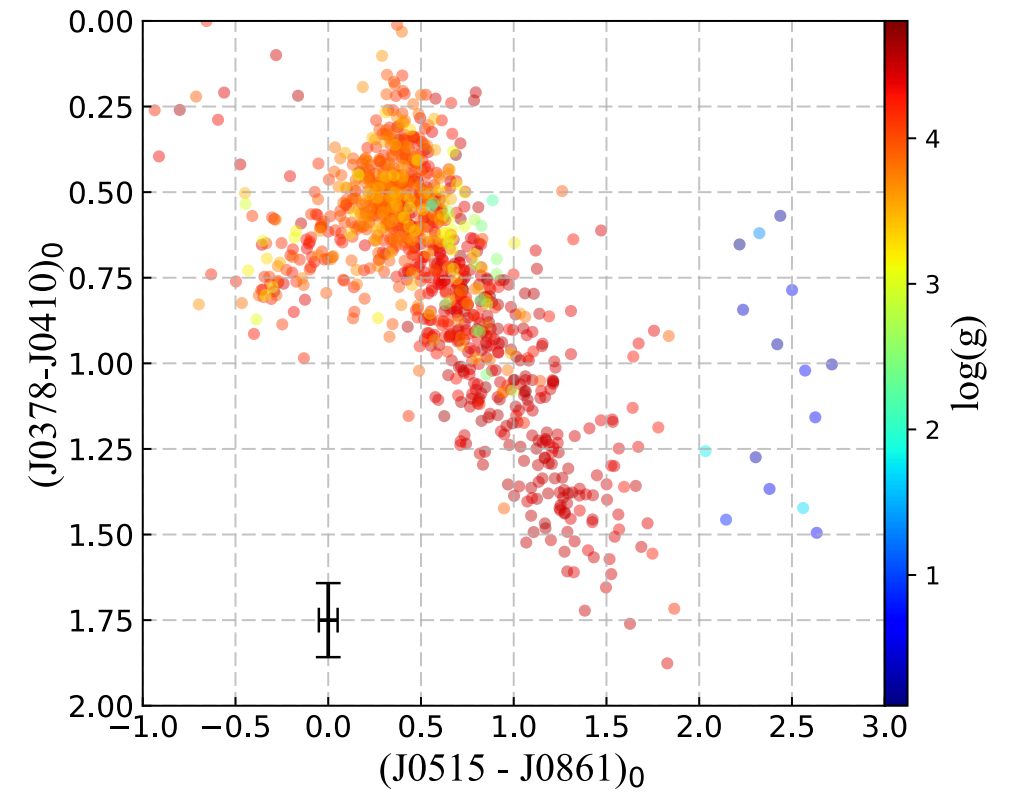
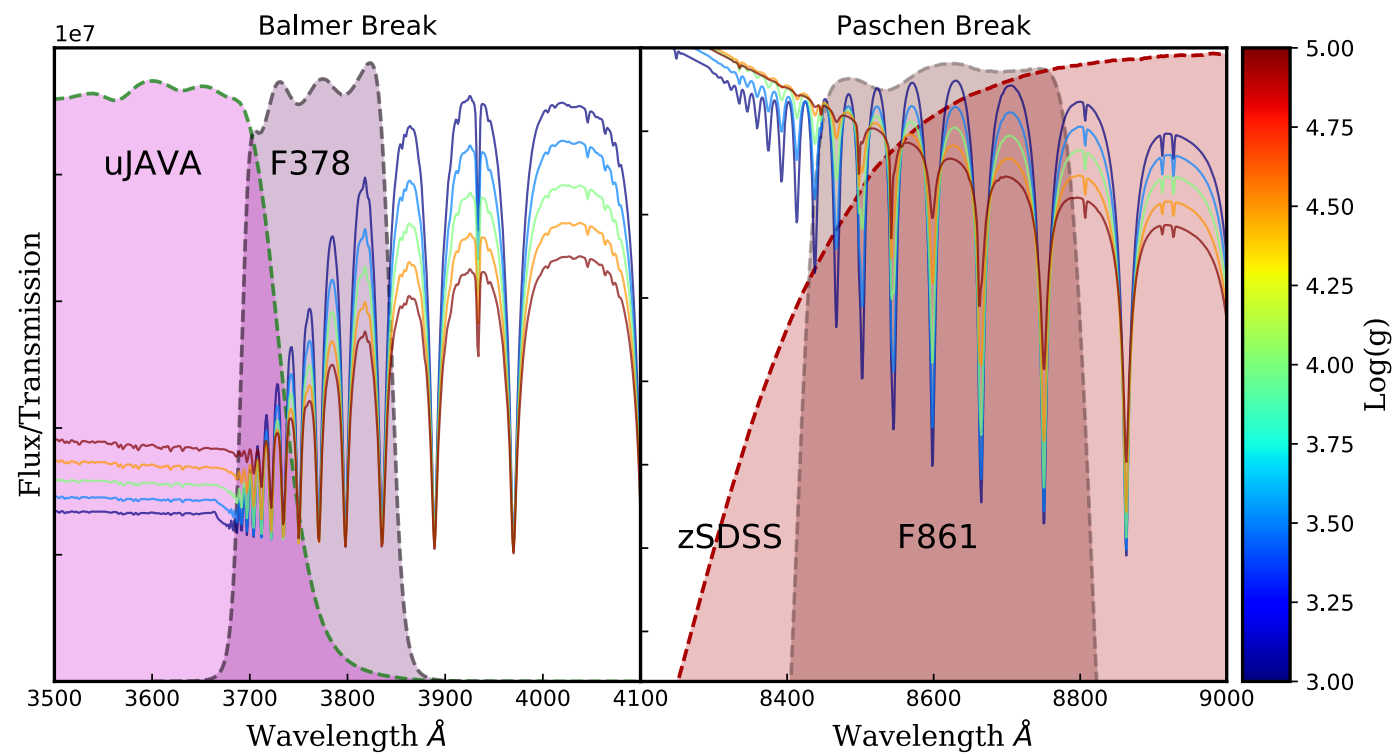
Carbon (Synthetic)



NEXT STEP: SURFACE GRAVITY



NEXT STEP: SURFACE GRAVITY



(Santucci et al. 2015)

Whitten et al. (in prep.)

CONCLUSIONS

- Parameter determinations are possible with J-PLUS
- ANNs are a option
- Training with SEGUE synthetic magnitudes is possible
- Further work needed to reduce uncertainties ($[\text{Fe}/\text{H}] < -2.5$ upturn)
- We anticipate *significant* improvement with more data!
- Future work: $\text{Log}(g)$, $[\text{Mg}/\text{Fe}]$



Thanks to
Vini M. Placco, Timothy C. Beers,
Spencer Clark, Alessandro Ederoclite,
J-PLUS Collaboration