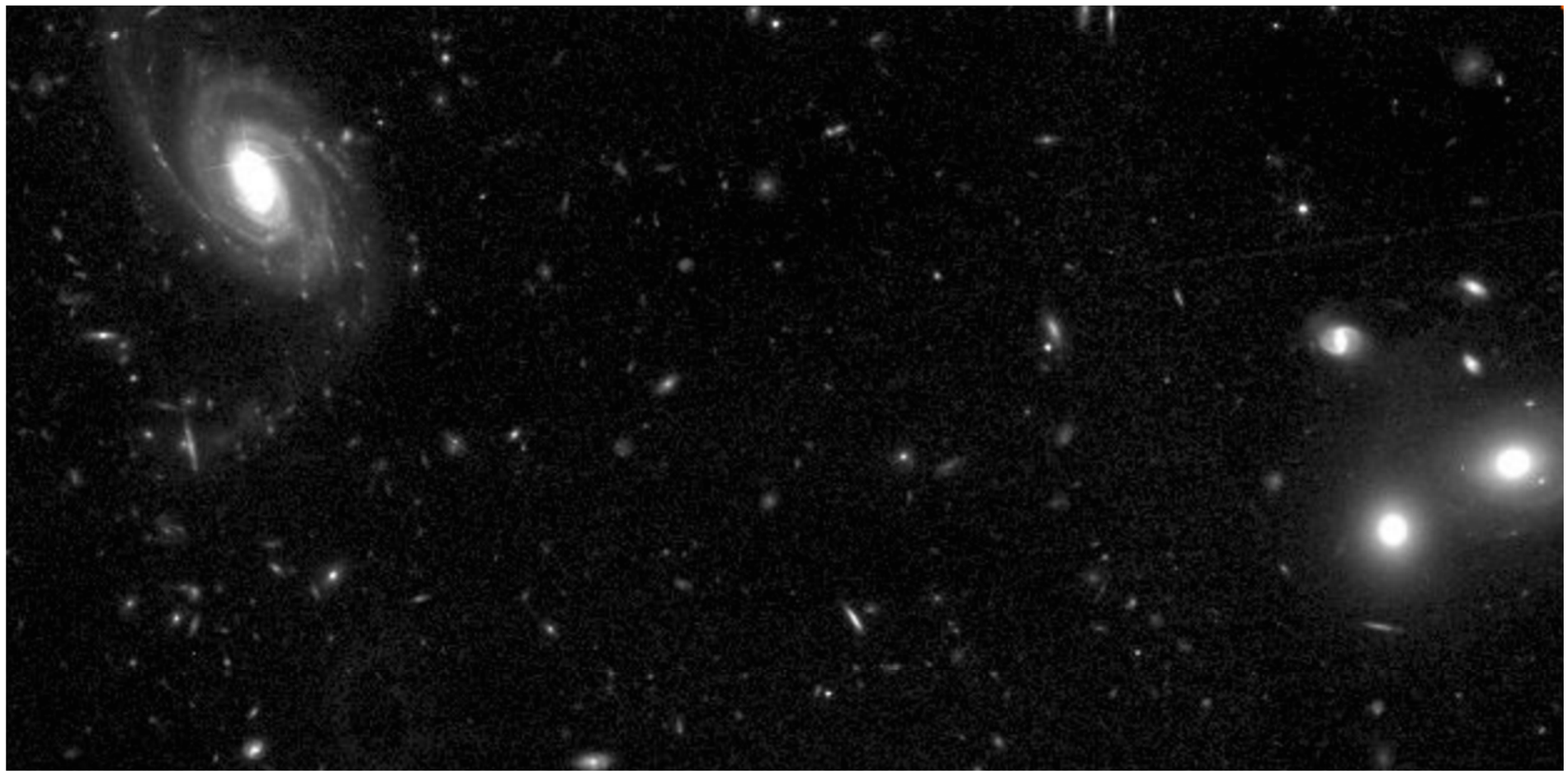
Composite Galaxy SEDs

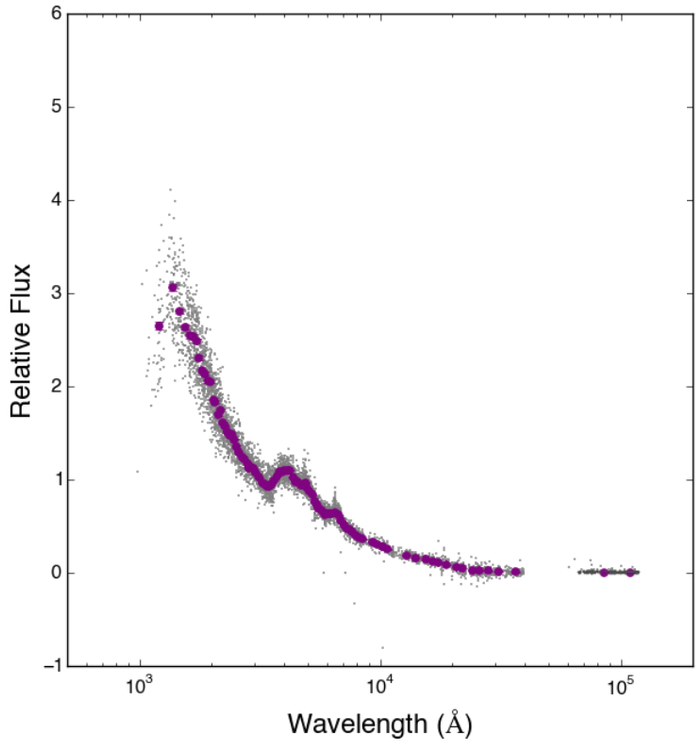


Ben Forrest
ASTR689
November 10th, 2015

Galaxy Evolution

- Galaxies rich in cool gas have significant amounts of star formation.

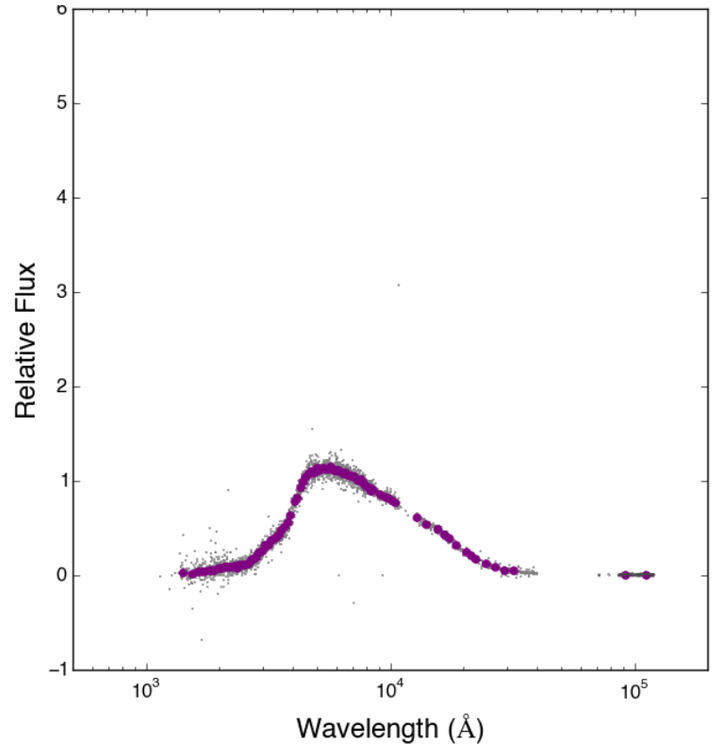
- This shows up as large amounts of blue light from young, massive stars.

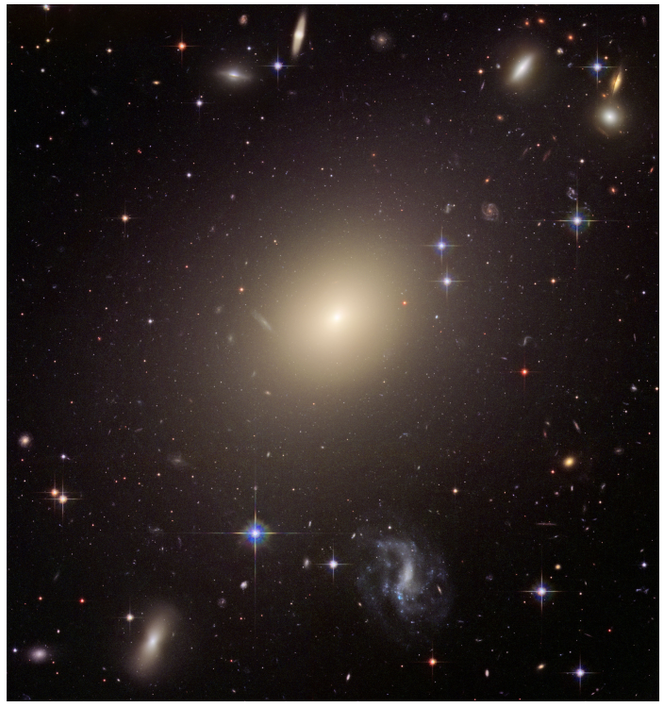


Galaxy Evolution

- As this cool gas is used up, the galaxy shuts off star formation and becomes quiescent.

- The massive stars die out quickly, and smaller, redder stars remain.



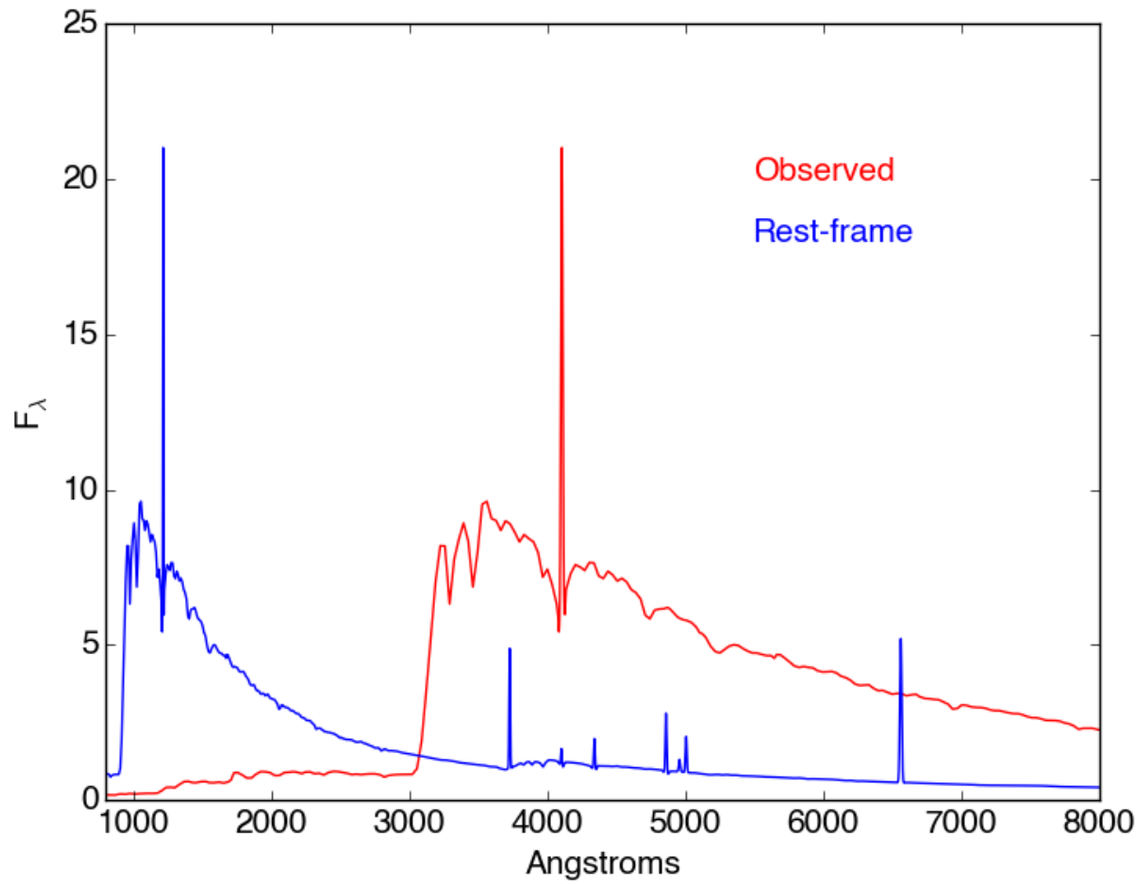


Redshifts

- Redshift is a phenomenological Doppler shift, where light moving away from the observer appears stretched and shifted to longer (redder) wavelengths.

- This effect is caused by the expansion of space, causing more distant objects to appear with larger redshifts.

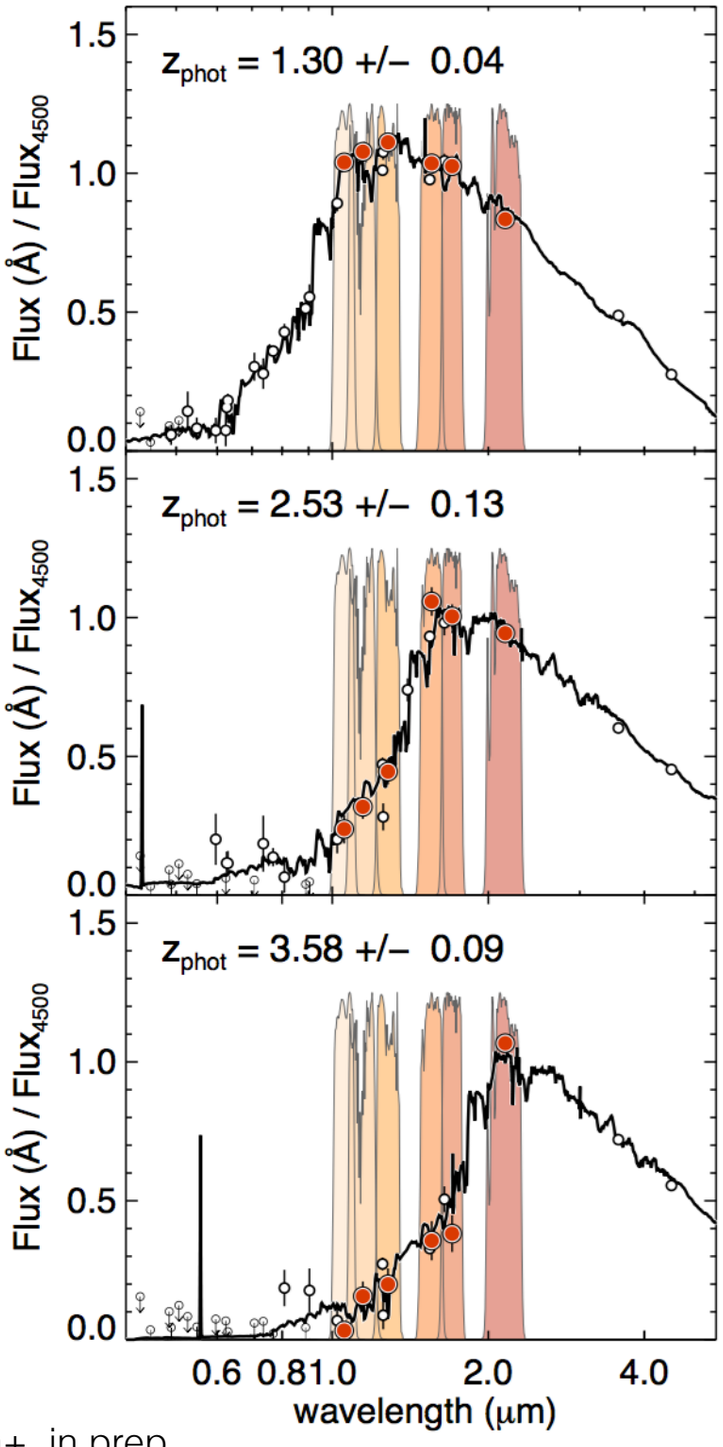
- Redshift can be determined from a spectrum by identifying a specific feature and comparing its observed wavelength to its rest-frame wavelength.



Redshifts

- Obtaining redshifts via photometry is somewhat more limited, due to the narrow width of emission lines compared to filter throughput functions.

- Often, one relies on finding a break such as D4000 or the Lyman limit.

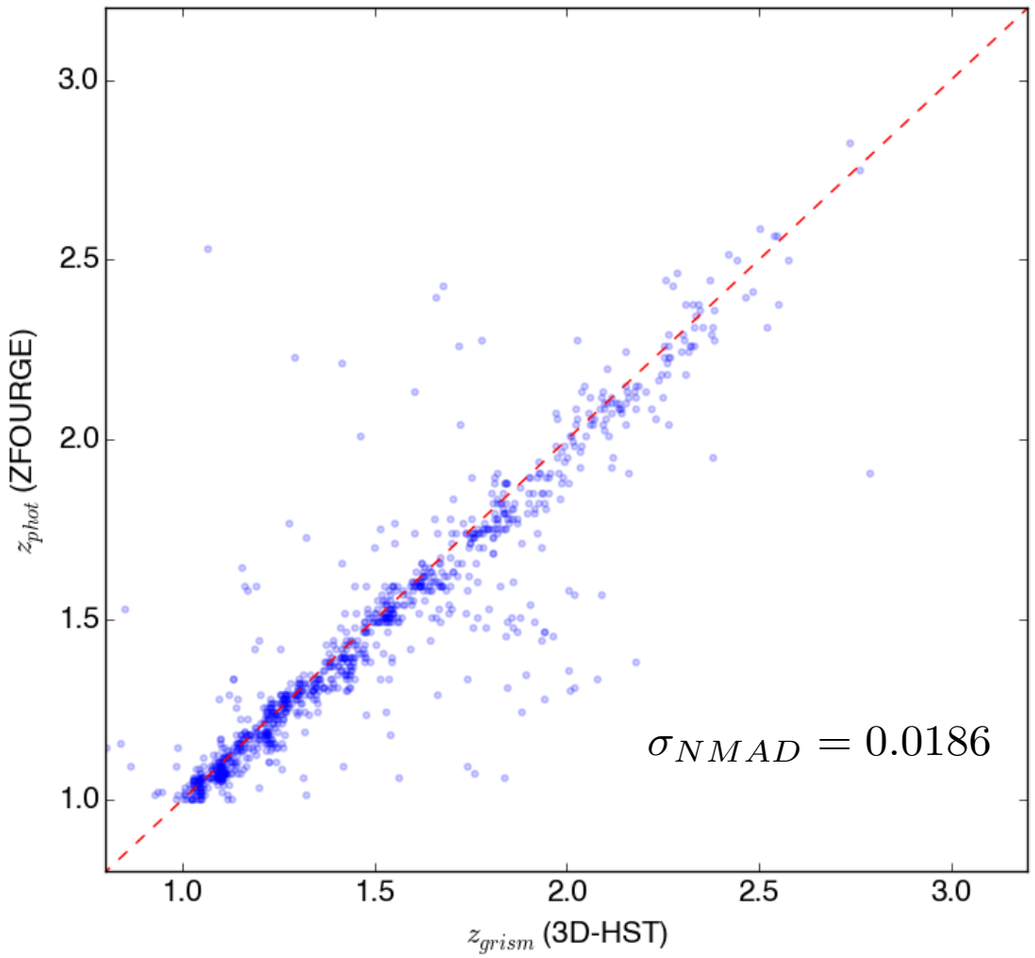


Straatman+, in prep

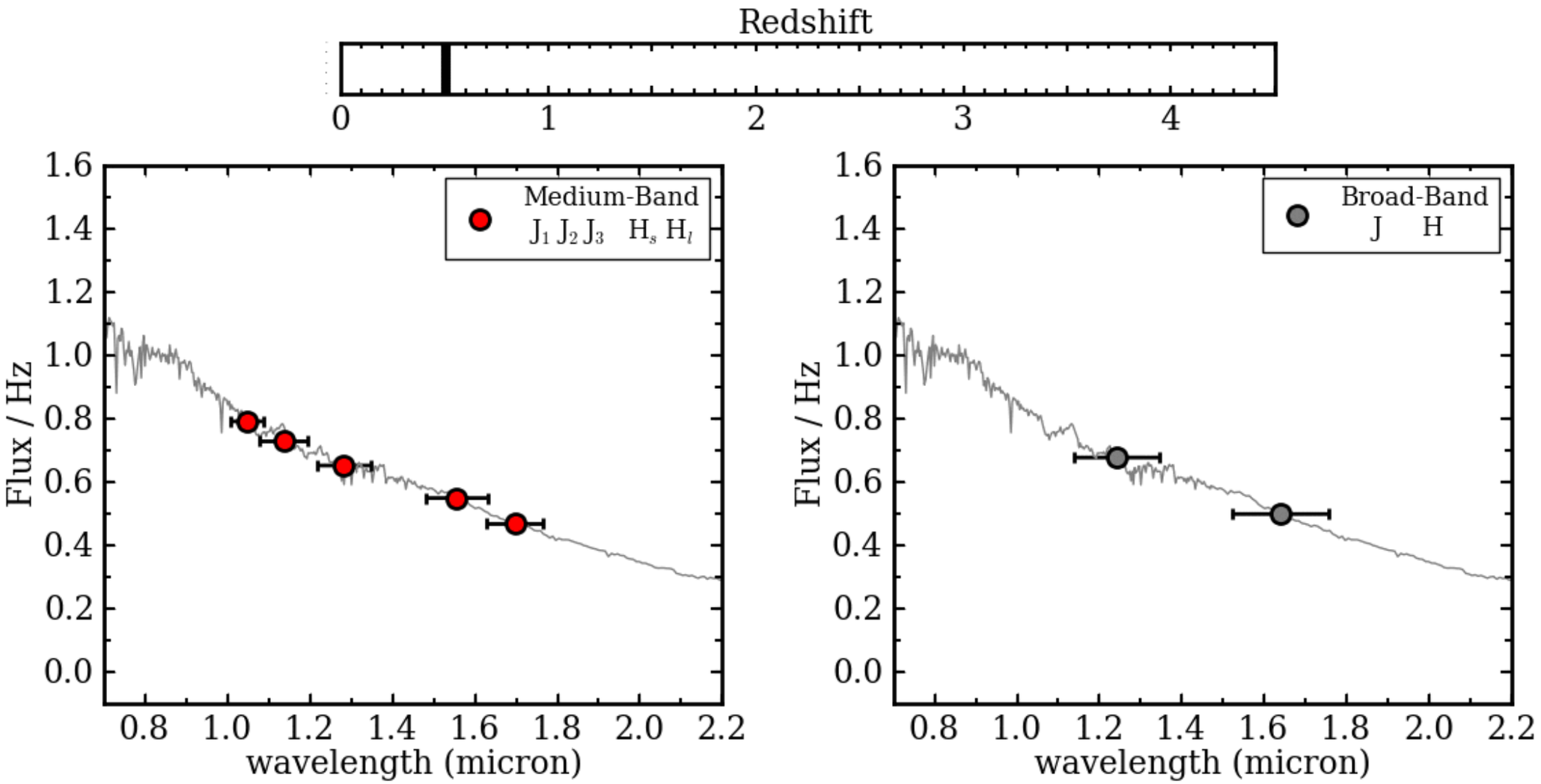
Redshifts

- Unfortunately, spectra require large amounts of time on a telescope, and also require brighter targets than photometry.

- Thus, if we are looking for large samples, photometry is the observation of choice.



ZFOURGE

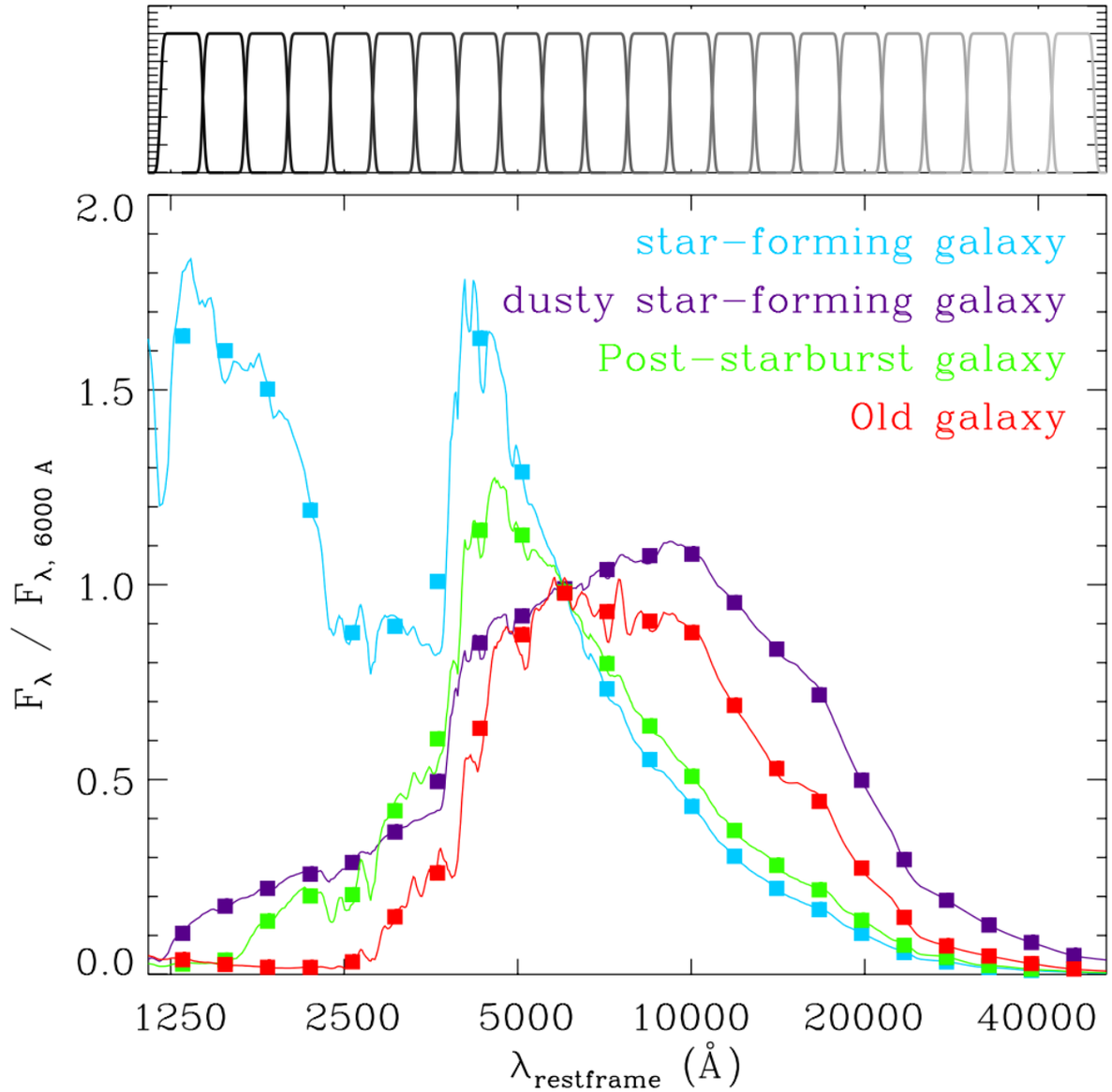

Redshift
0
1
2
3
4
Medium-Band
J1 J2 J3 Hs Hl
Broad-Band
J H
Flux / Hz
wavelength (micron)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2

Composite Galaxy SEDs

- Synthetic rest frame photometry is taken from template fits to compare intrinsic galaxy SEDs.

$$b_{12} = \sqrt{\frac{\Sigma(f_\lambda^{ob1} - a_{12} f_\lambda^{ob2})^2}{\Sigma(f_\lambda^{ob1})^2}}$$

$$a_{12} = \frac{\Sigma f_\lambda^{ob1} f_\lambda^{ob2}}{\Sigma(f_\lambda^{ob2})^2}$$

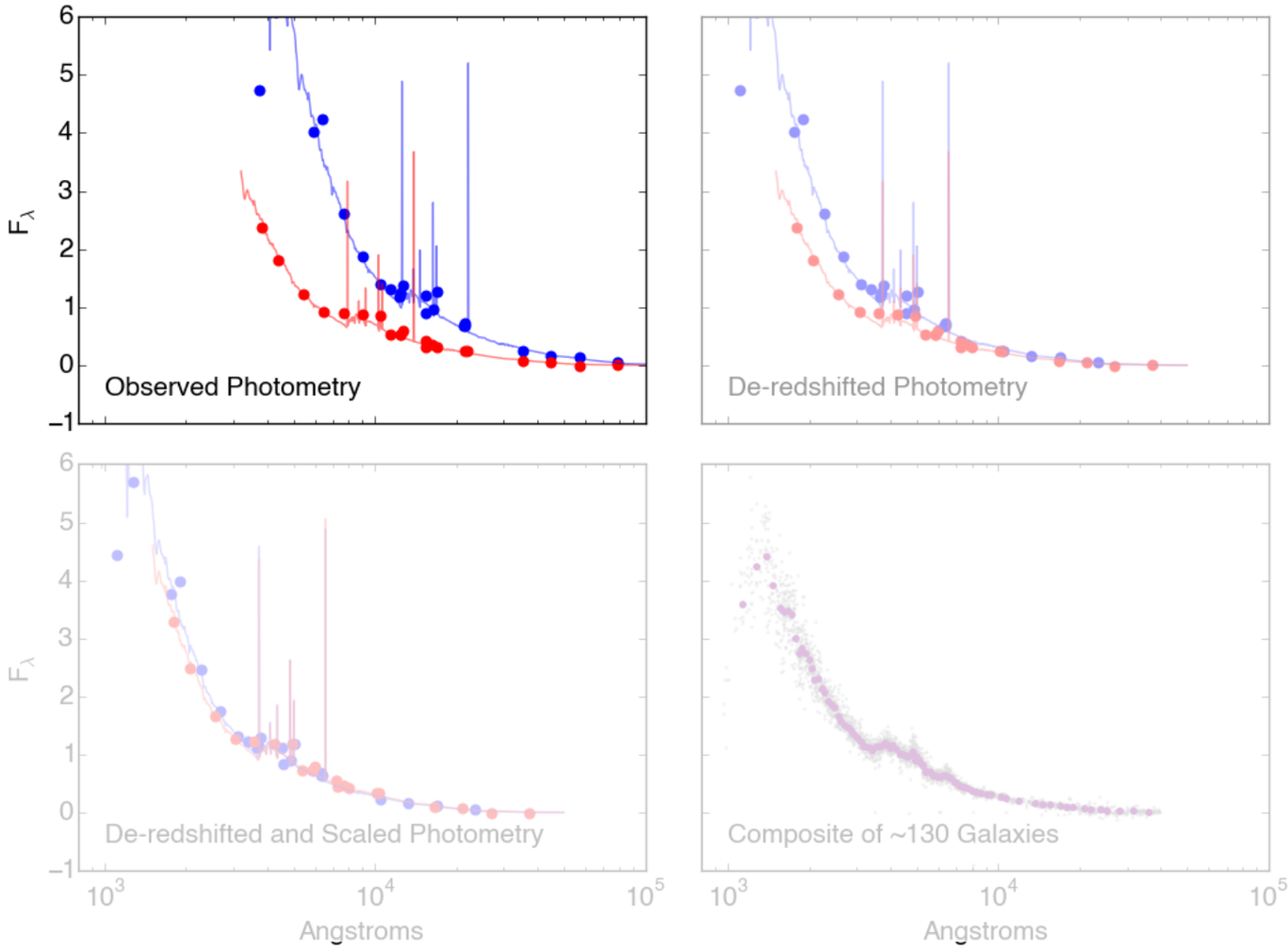


Kriek+2011

Composite Galaxy SEDs

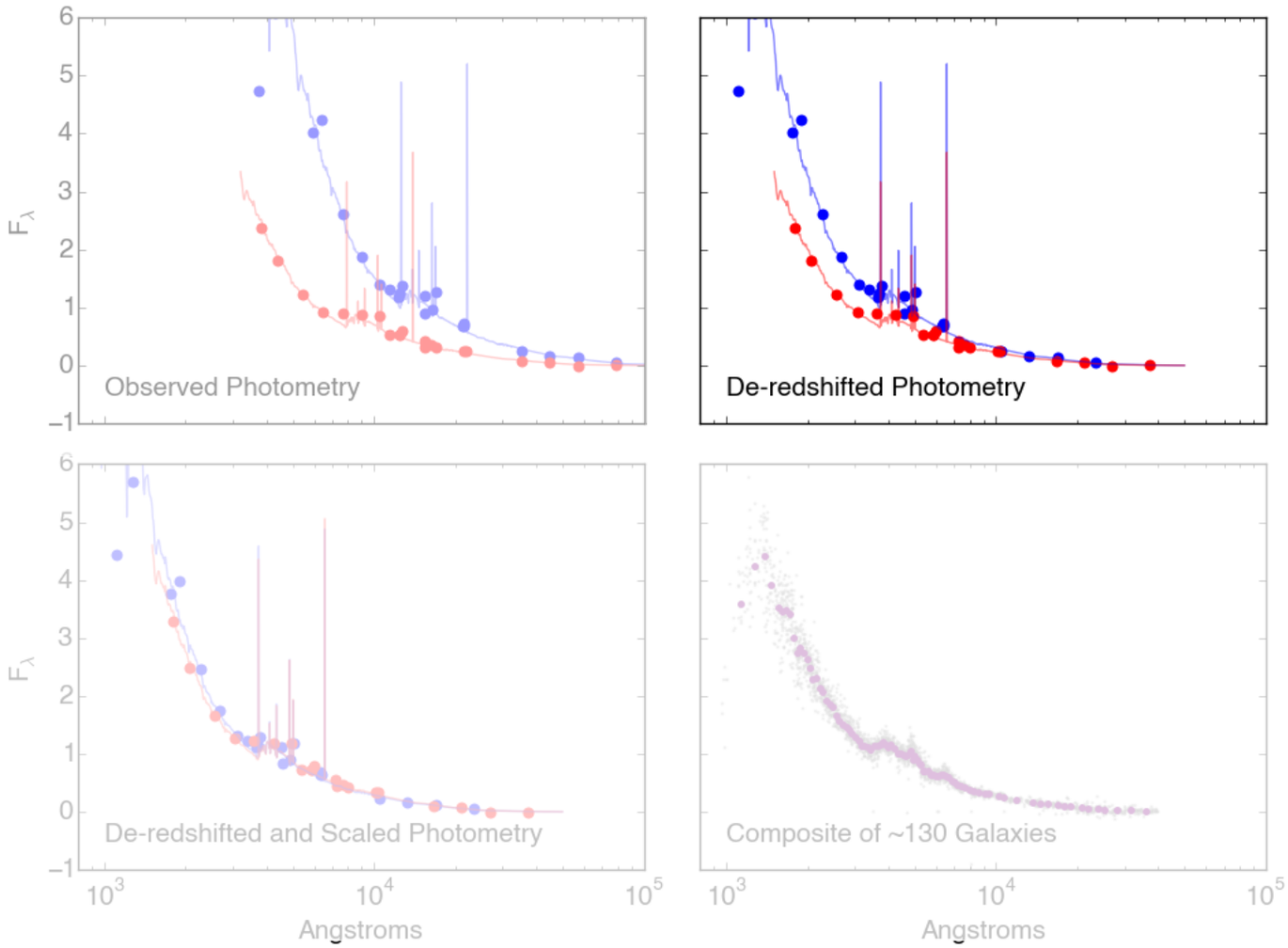
- For our large sample of well-observed galaxies, we group galaxies together based on rest-frame synthetic photometry into composites.

- There are potentially many grouping algorithms that can accomplish this (HW 4).



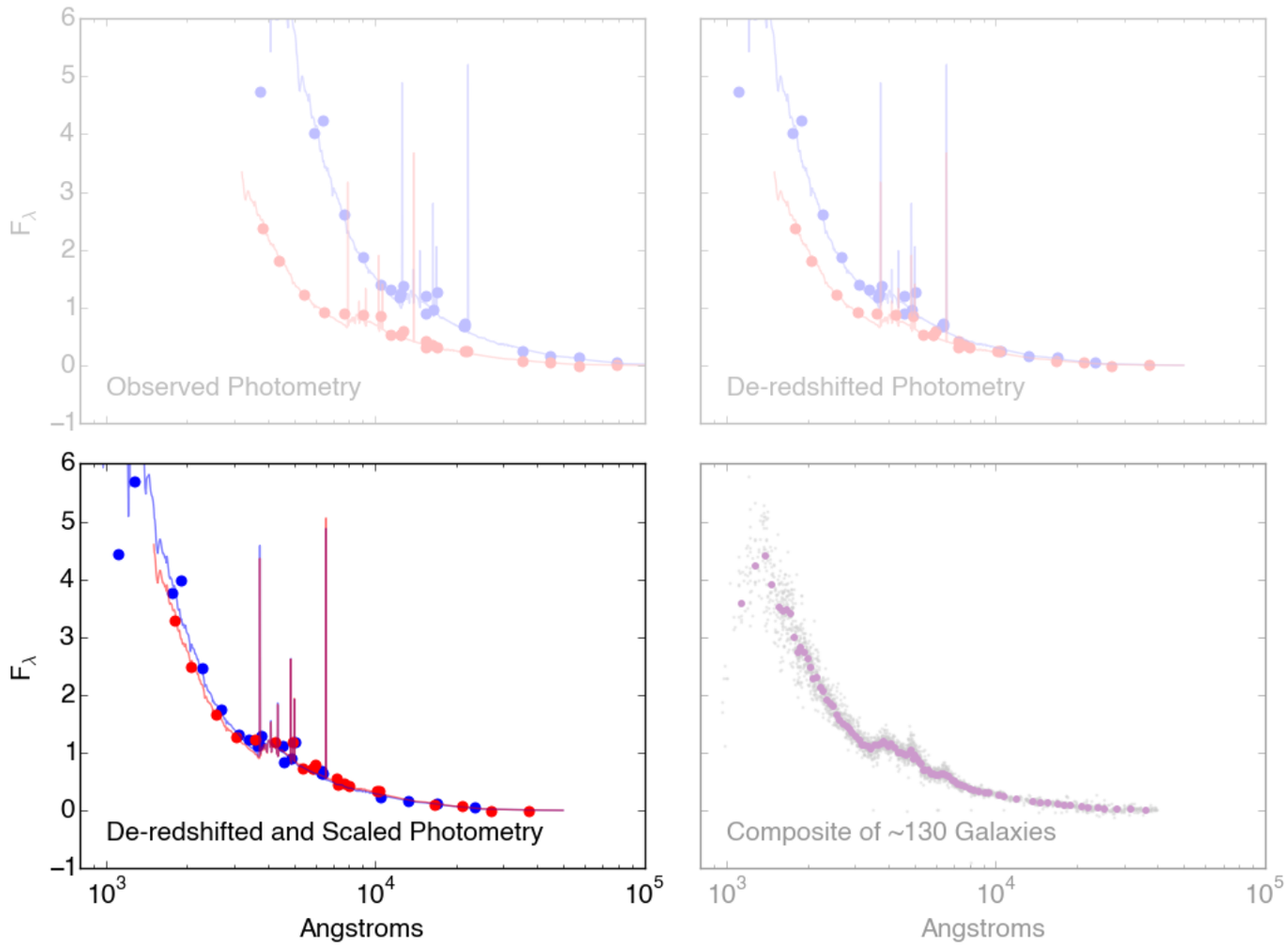
Composite Galaxy SEDs

- The observed photometry of these galaxies is then de-redshifted into the rest frame ($\lambda_{REST} = \frac{\lambda_{OBS}}{1+z}$)…



Composite Galaxy SEDs

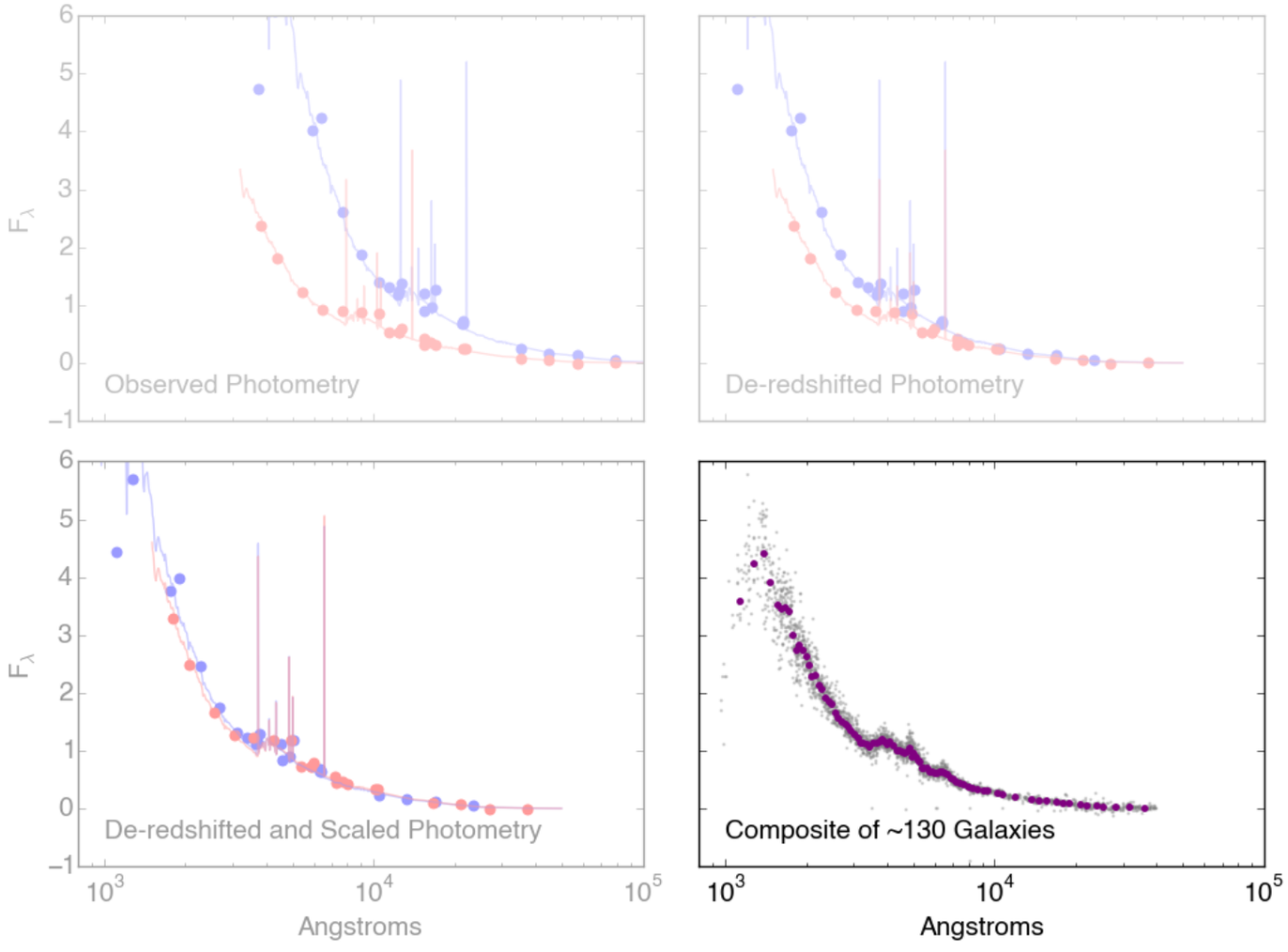
- …and scaled to match at a particular wavelength.



Composite Galaxy SEDs

- This process is repeated for all the galaxies in a composite grouping to obtain nearly continuous coverage of the intrinsic SED from ~0.1-4 μm.

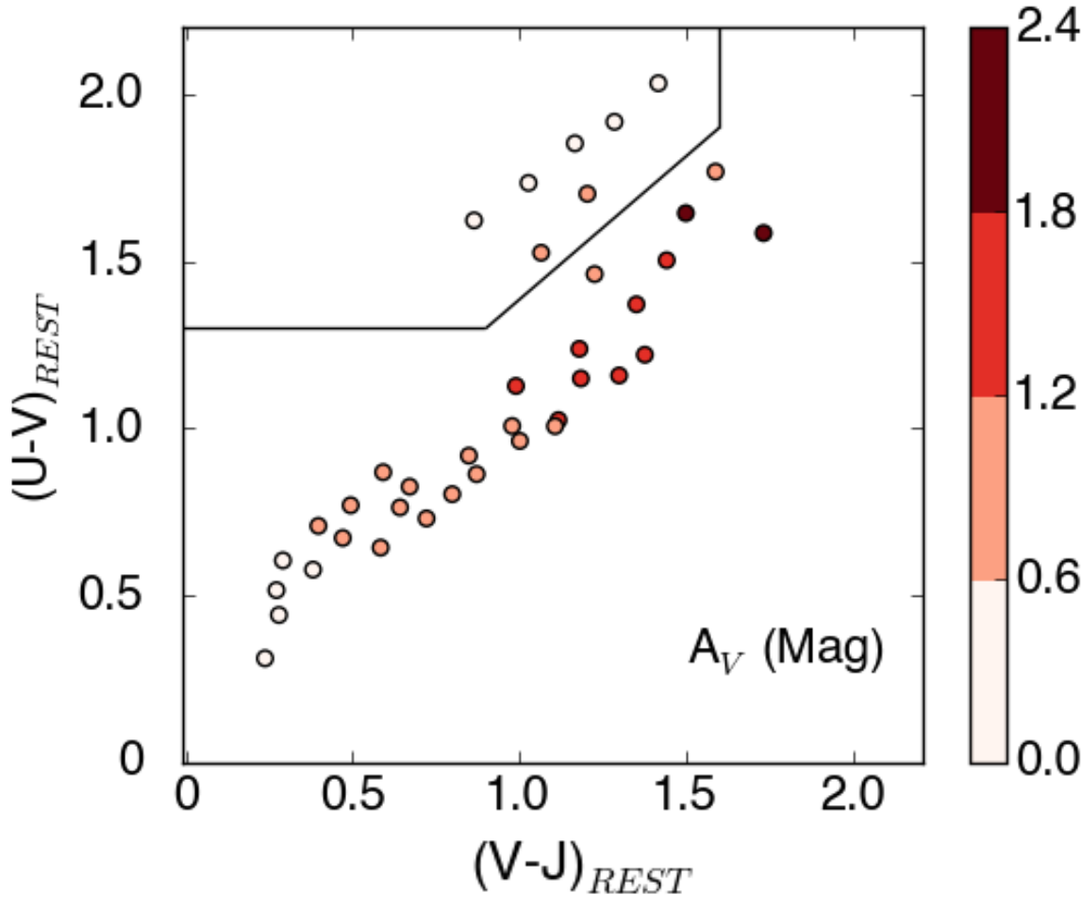
- Median values in various wavelength bins are taken to create our final composite SED.



Galaxy Categorization

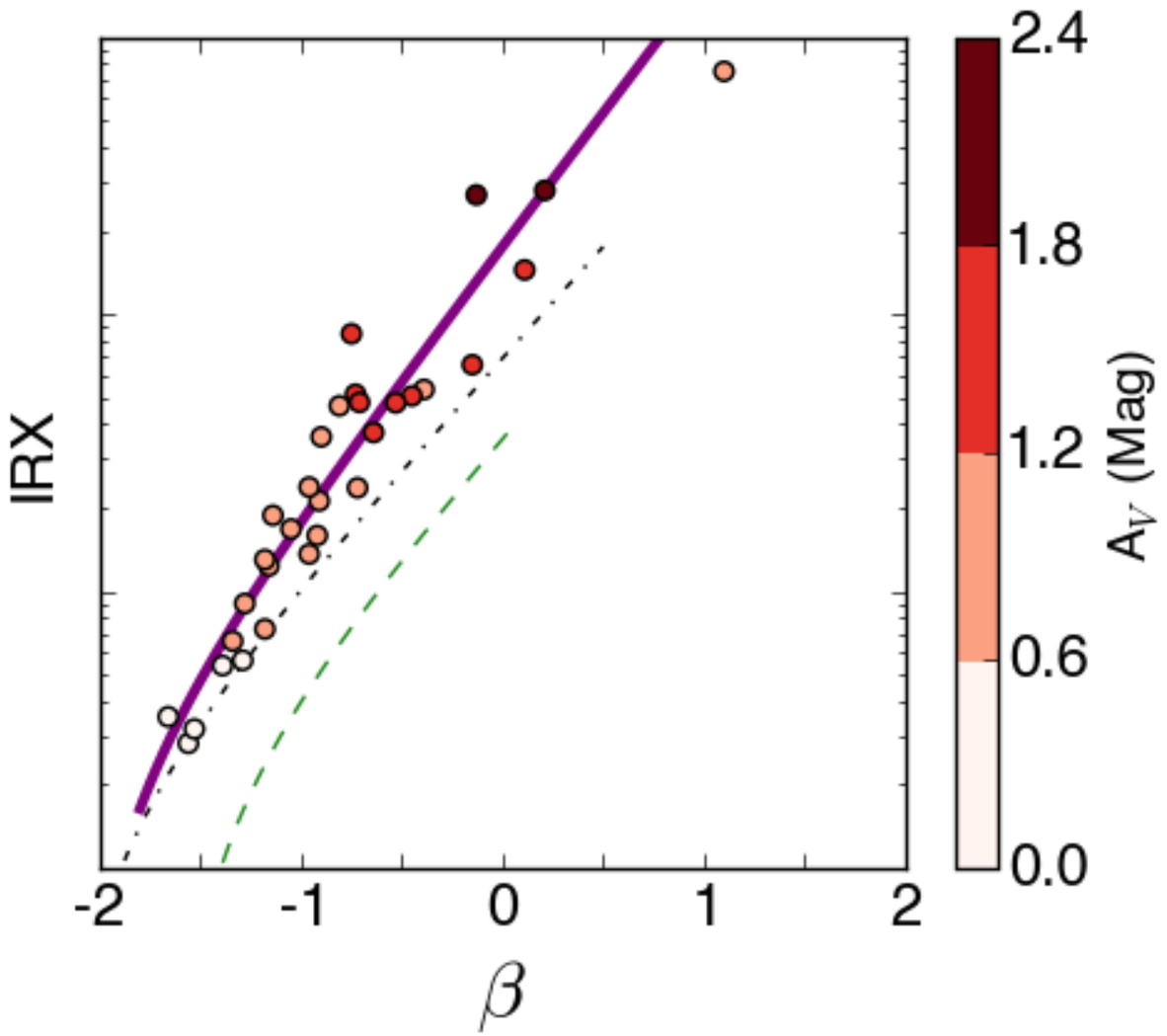
- The *UVJ* color-color diagram is an empirical test for determining if a galaxy is forming stars.

- It compares the ratio of blue to green light (young stars) to the ratio of green to red light (old stars).



Dust Content

- Dust can also obscure star formation
- Dust grains can be heated by ultraviolet (UV) light, which is then reprocessed and emitted in the infrared (IR).
- The ratio of IR to UV light (IRX) is an indicator of dust content.

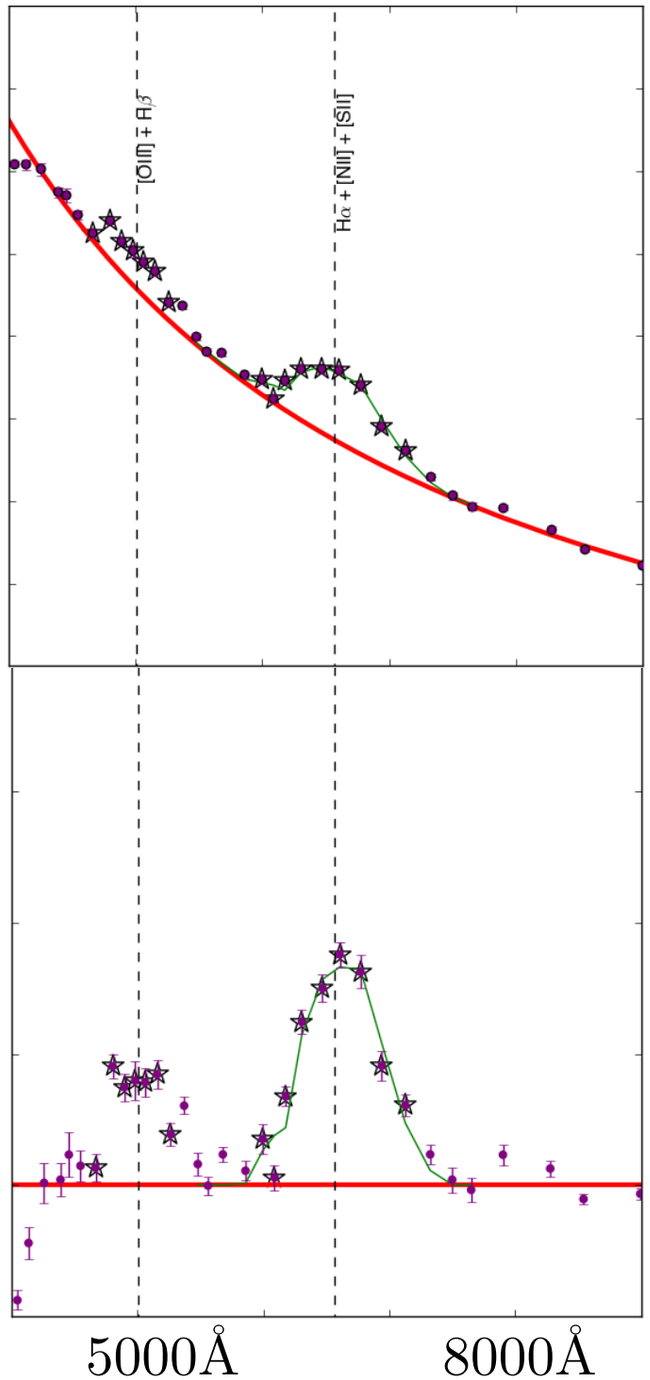


Hα Emission

- Hα emission occurs when a hydrogen electron falls from the third excited state to the second.

- However, it is very rare for hydrogen to be excited to the third energy state without being ionized, so Hα emission is associated with ionizing radiation.

- Thus, this emission is indicative of active star formation, where gas is being ionized by newly formed stars.



Conclusions

- Determining redshifts from limited photometric coverage is an area of current research.

- Building composite SEDs with precise redshifts allows us to constrain properties of galaxies that would normally require spectroscopy with photometry alone.

- Identifying similar galaxies from limited observations is a problem that we will explore in the next HW.