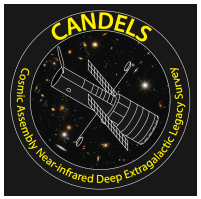

From Redshift Calibration To Physical Properties Of Galaxies With Self Organizing Maps

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Caltech/ IPAC

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Base of this talk

1. Do we have enough data representative of all galaxies? (e.g. for redshift calibration)

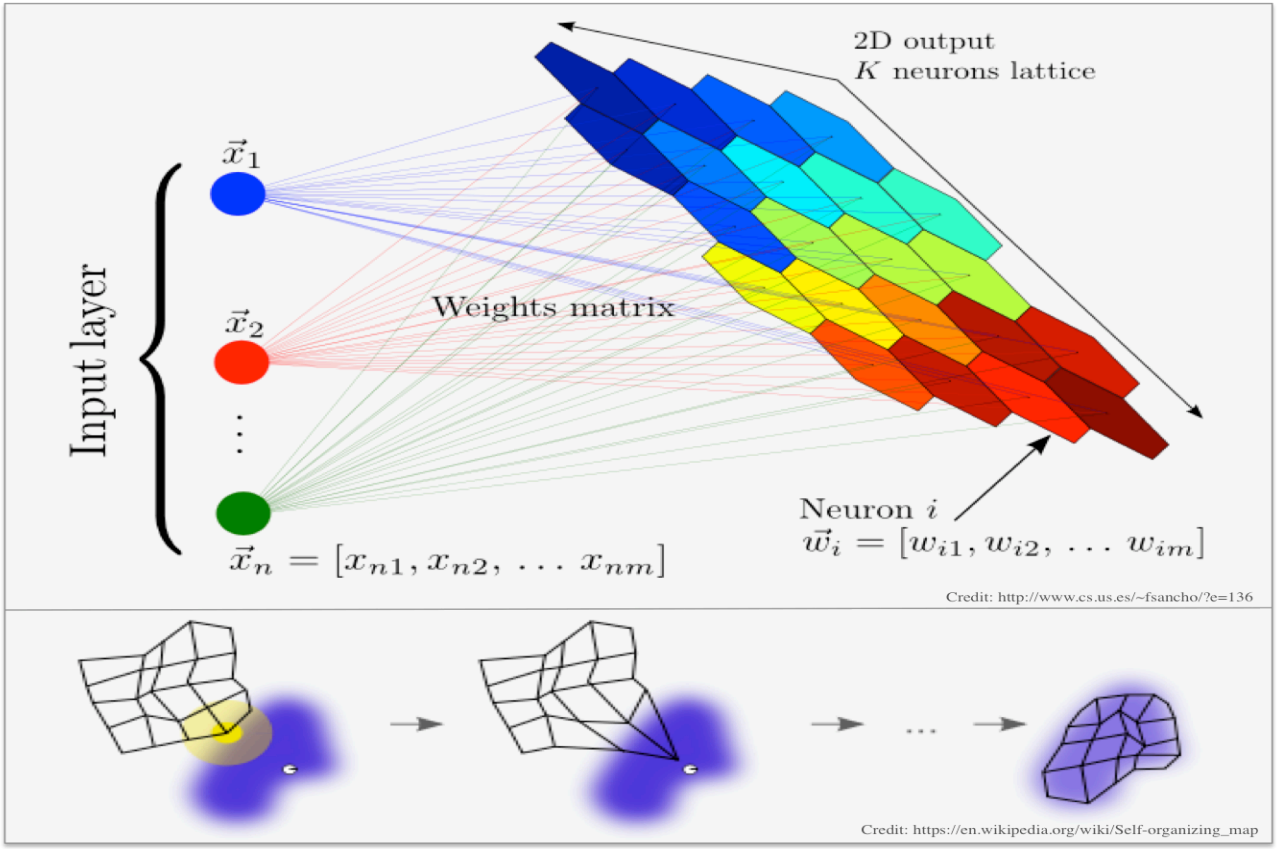
2. Do we understand the parameter space made by theoretical libraries of galaxies? (e.g. for SED fitting)

3. Do we have computational means to analyze big data from current and upcoming missions?

Neural Networks can help …

Self Organizing Maps (SOMs)

Unsupervised neural networks that reduces dimensionality and preserves topology



1. Do we have enough galaxies? Photometrically

- Are we finding new classes of galaxies, new SEDs?
- How are future multi-band large area surveys helpful?
- How are faint galaxies different from bright ones?

1. Do we have enough galaxies? Spectroscopy

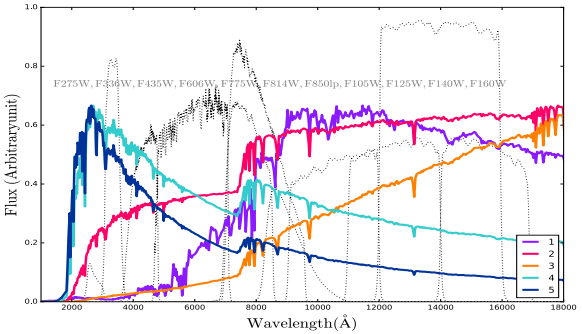
- Precision Cosmology → Precise redshifts of groups of galaxies $dz/(1+z) \sim 0.002$
- Need of spectroscopic sample to calibrate photometric redshifts, do we have enough?
- Random sampling not efficient
- Targeted spectroscopy:
  - Spatial cross-correlation method (Newman et al.)
  - Sampling from different types (SEDs) of galaxies with SOM(Masters et al.)

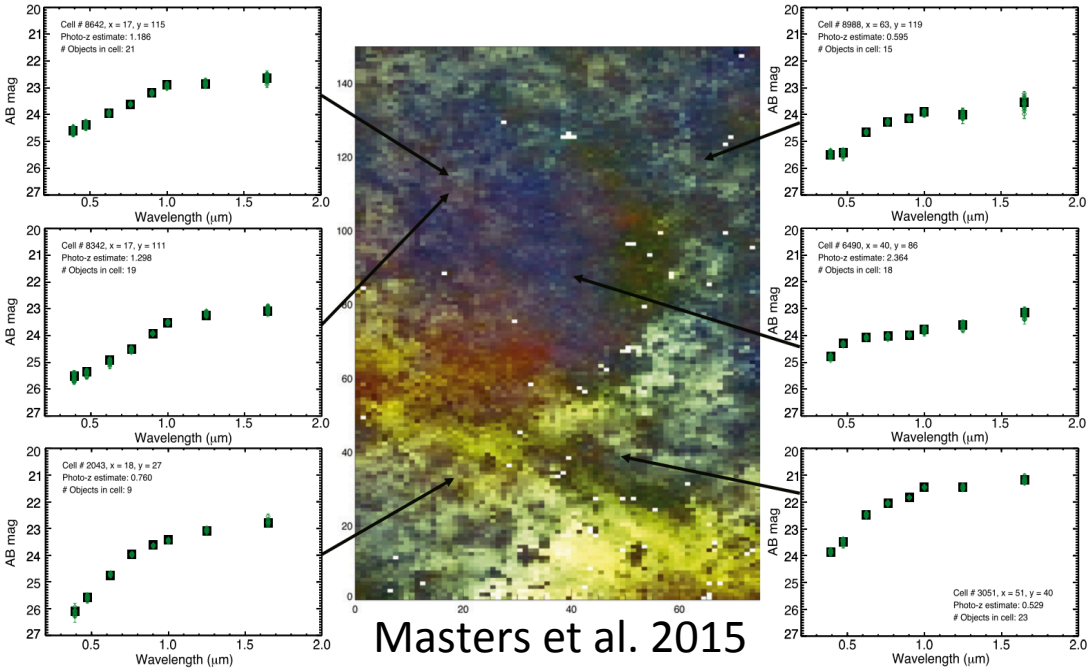
SOM application: Redshift Calibration, EUCLID

Multi-dimensional space defined by the colors of galaxies in consecutive filters in a photometric survey.

e.g. EUCLID from COSMOS:

(u-g), (g-r), (r-i), (i-z), (z-y), (y-j), (j-h)

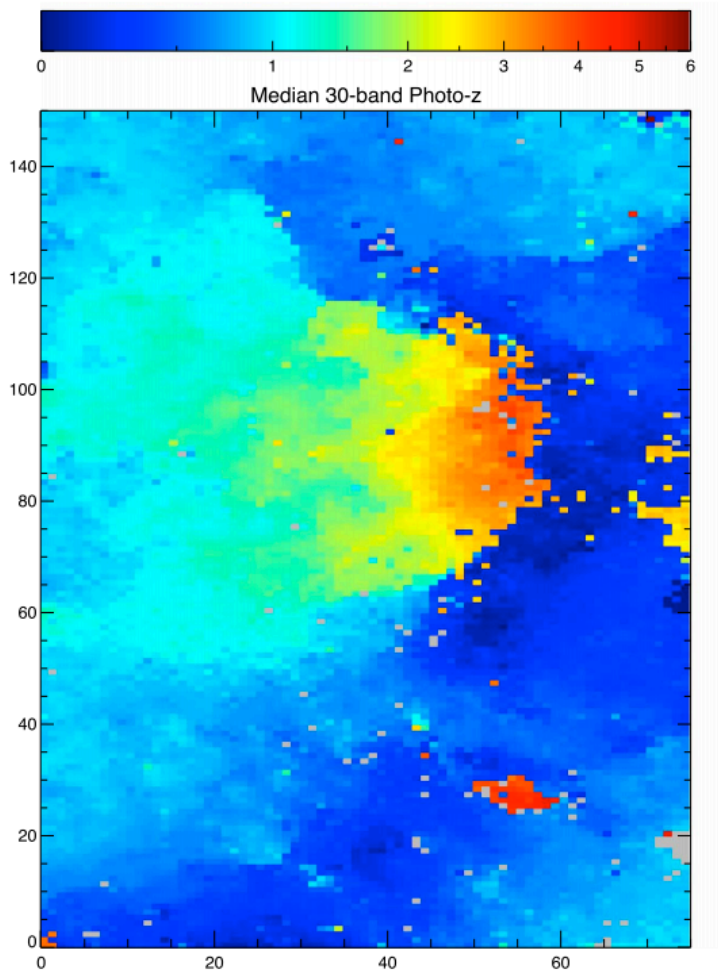


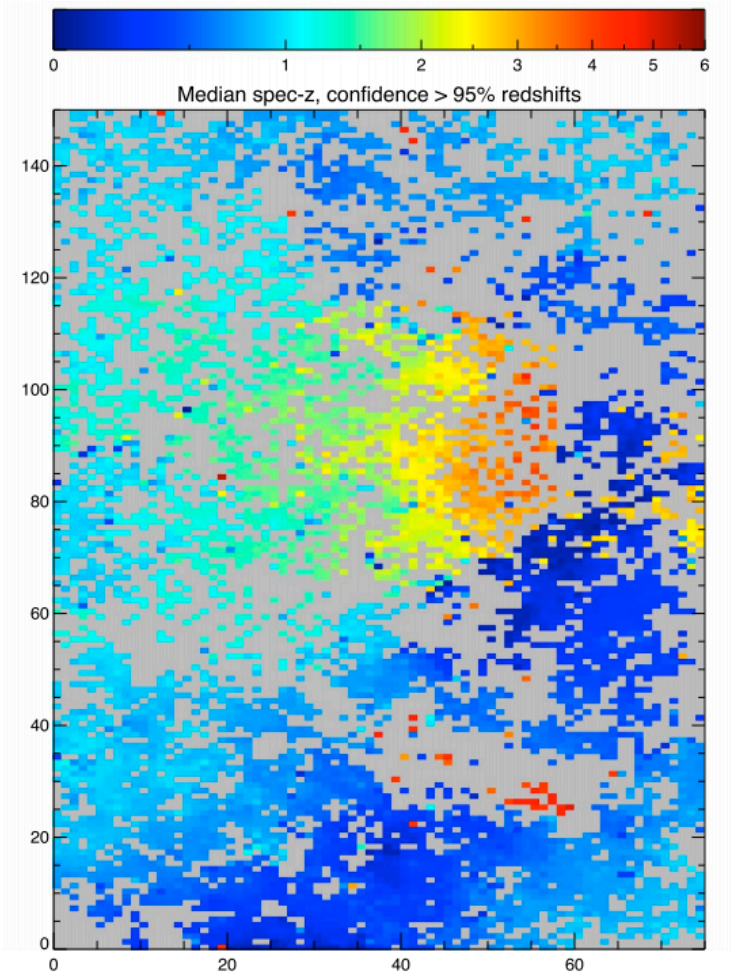


Masters et al. 2015

SOM reduces the multi dimensional parameter space to two dimensions

SOM application: Redshift Calibration, EUCLID

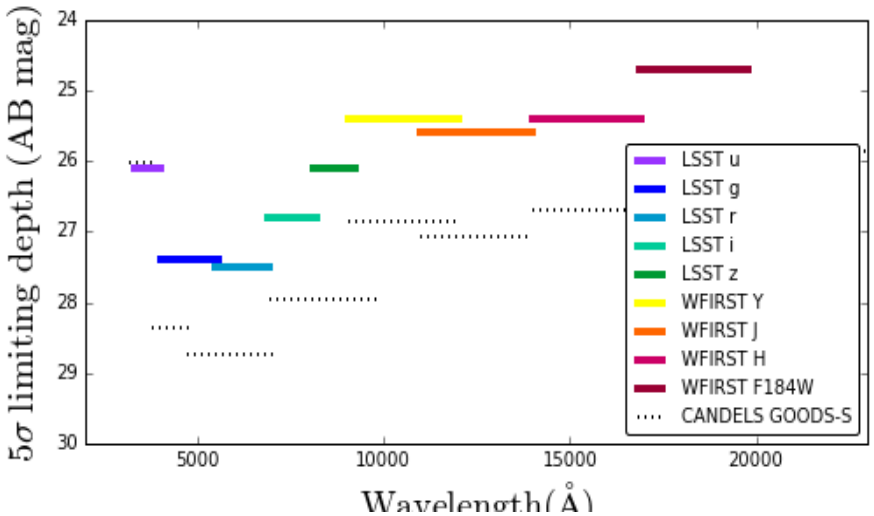


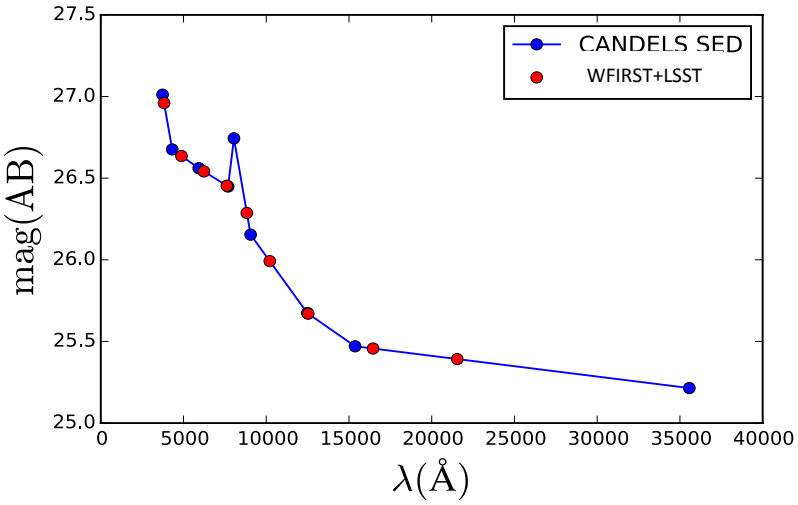


Masters et al. 2017, C3R2

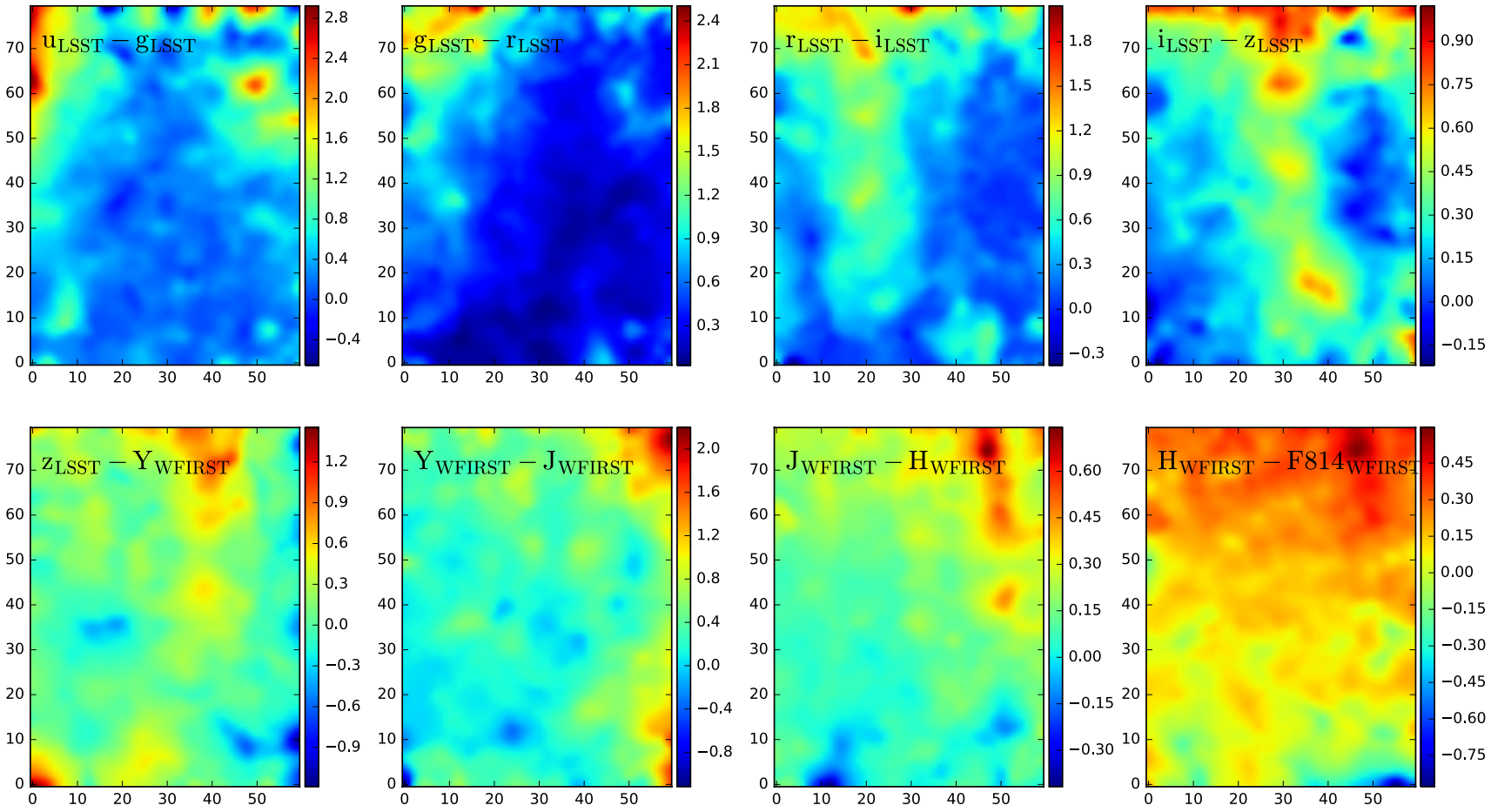
SOM application: Redshift Calibration, WFIRST

- WFIRST will go deeper than EUCLID (RIZ<25)
- CANDELS is the optimum choice of multi-band deep enough survey to mimic LSST+WFIRST

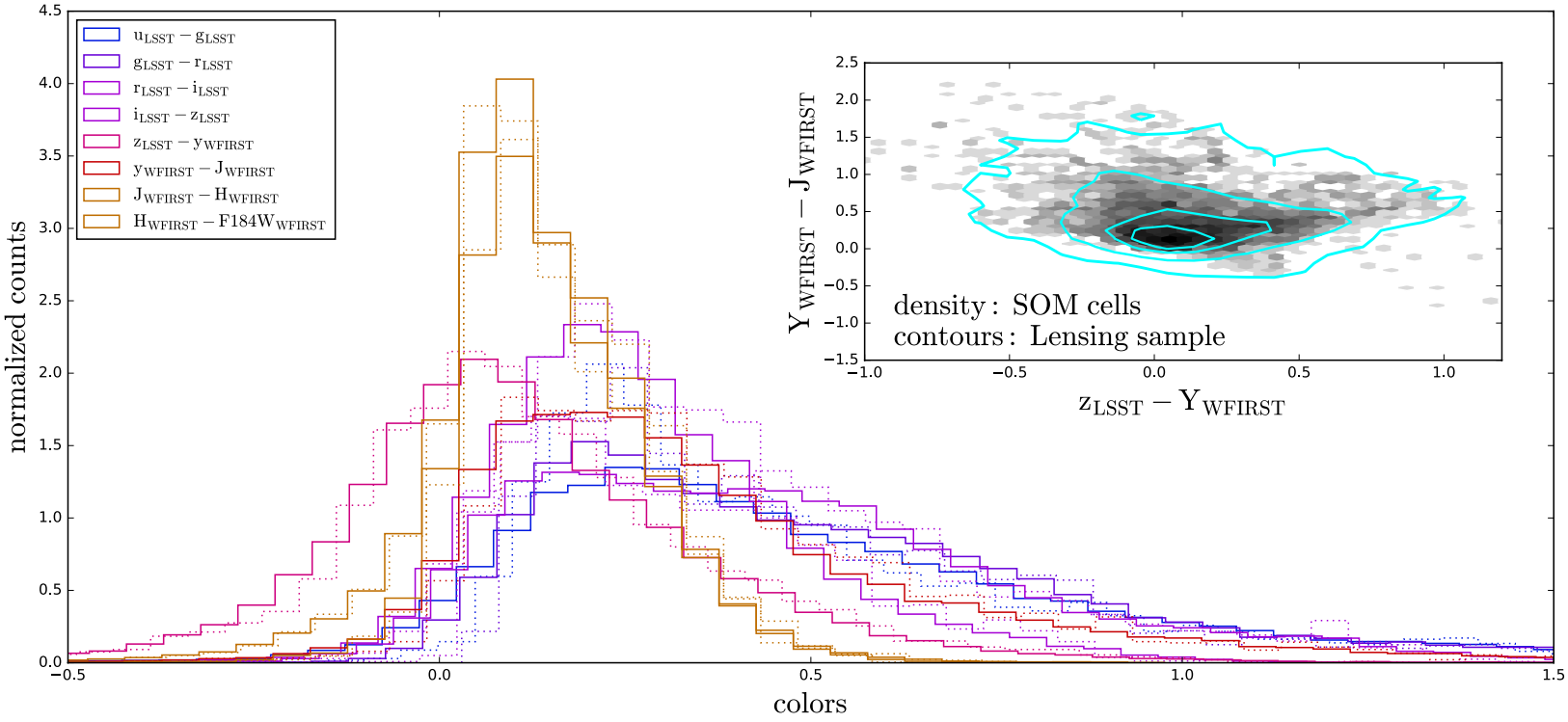




SOM application: Redshift Calibration, WFIRST

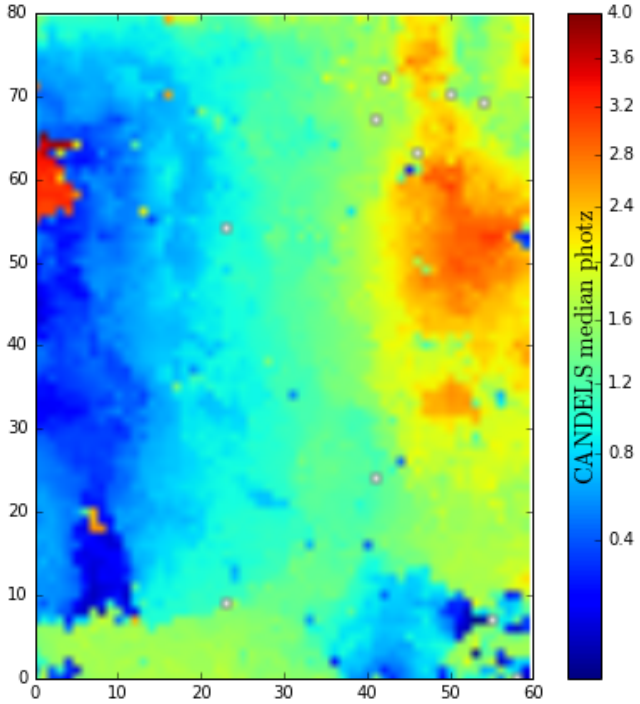


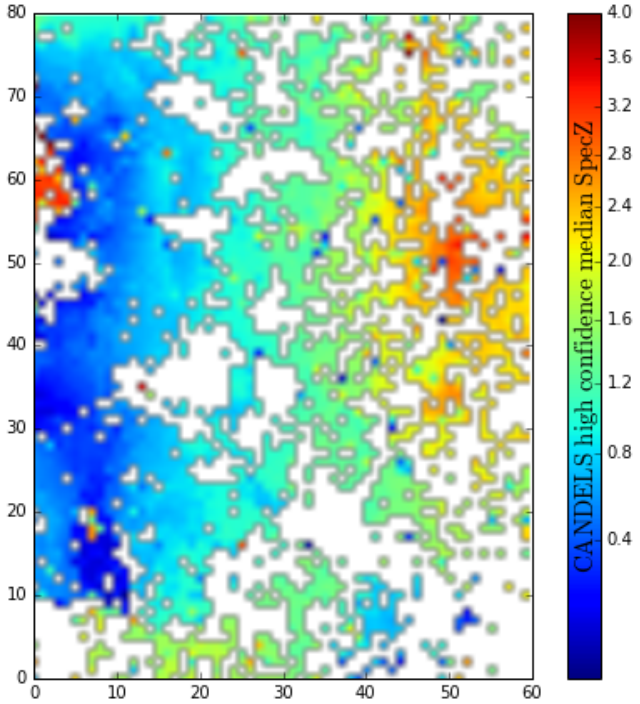
SOM application: Redshift Calibration, WFIRST



SOM is trained well, represents data perfectly

SOM application: Redshift Calibration, WFIRST

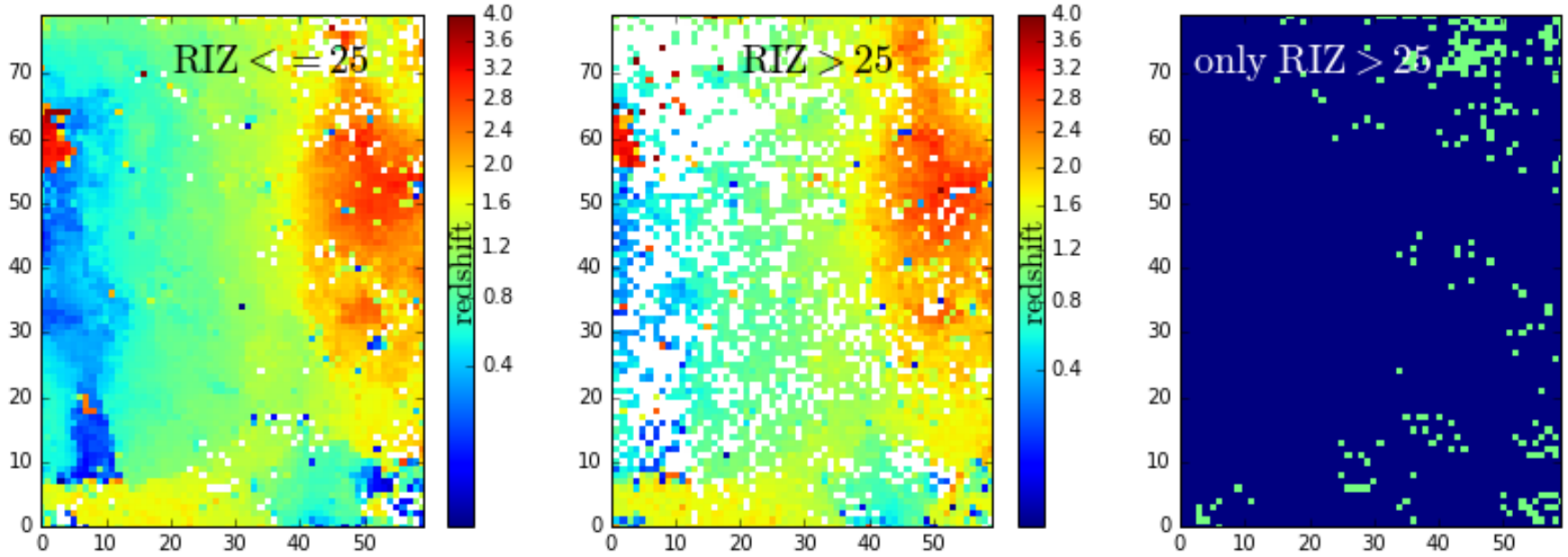




40% of CANDELS color-space is filled with spectroscopy

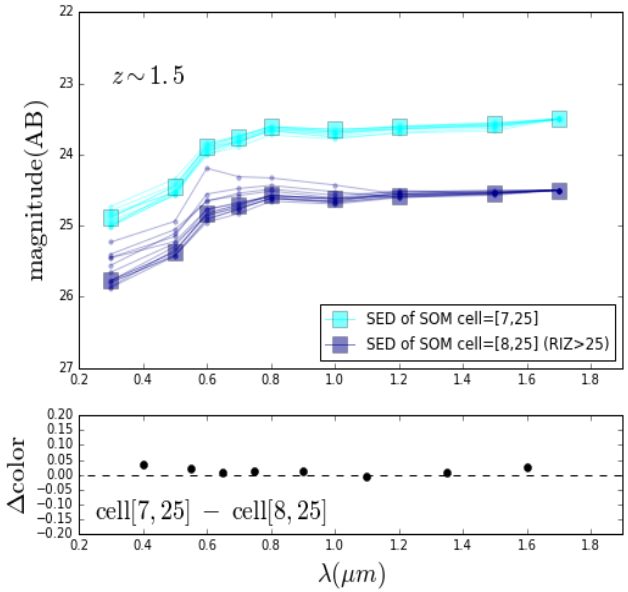
Is this color-space different from EUCLID?

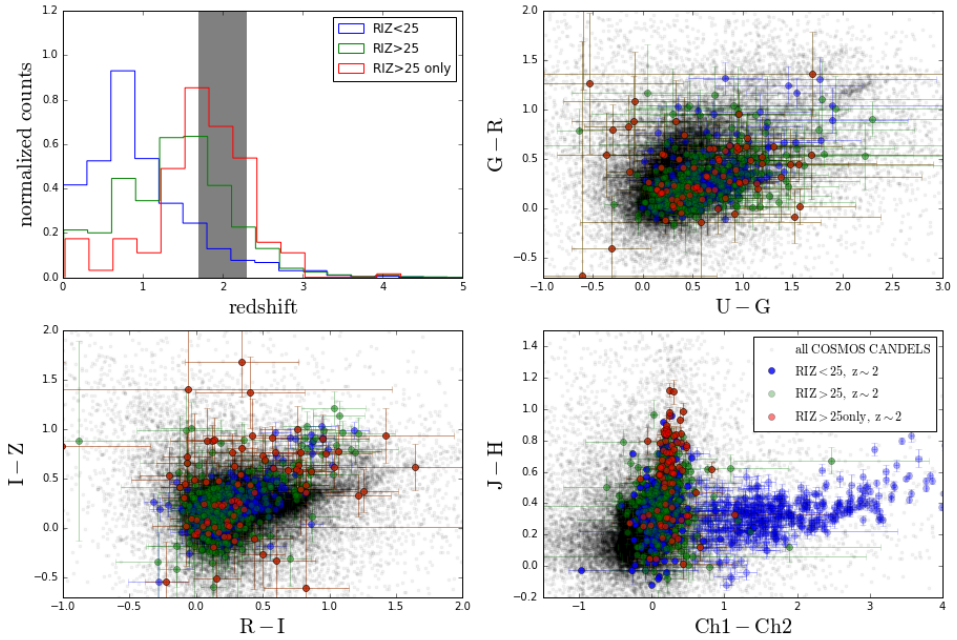
SOM application: Redshift Calibration, WFIRST



- Euclid (RIZ<25) will cover ~95% of the color space defined by the WFIRST simulated sample
- More than 90% of fainter (RIZ>25) galaxies in WFIRST have similar SEDs to bright ones.
- What about cells with no bright galaxy matched?

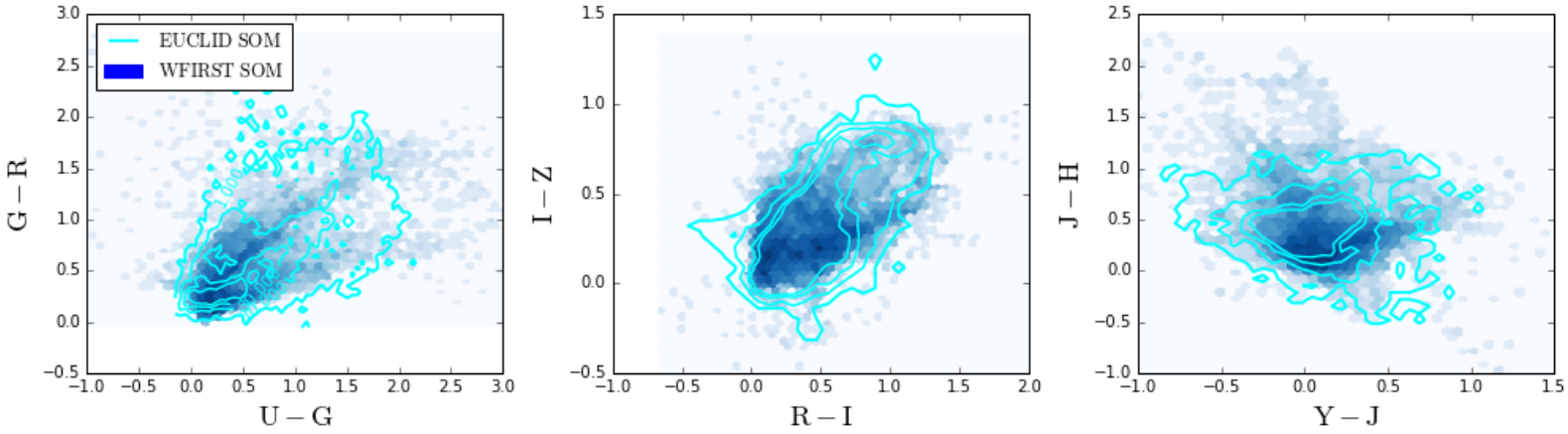
SOM application: Redshift Calibration, WFIRST





Faint galaxies* do not have different SED* shapes but larger errors → Galaxy samples representative

1. Do we have enough galaxies?



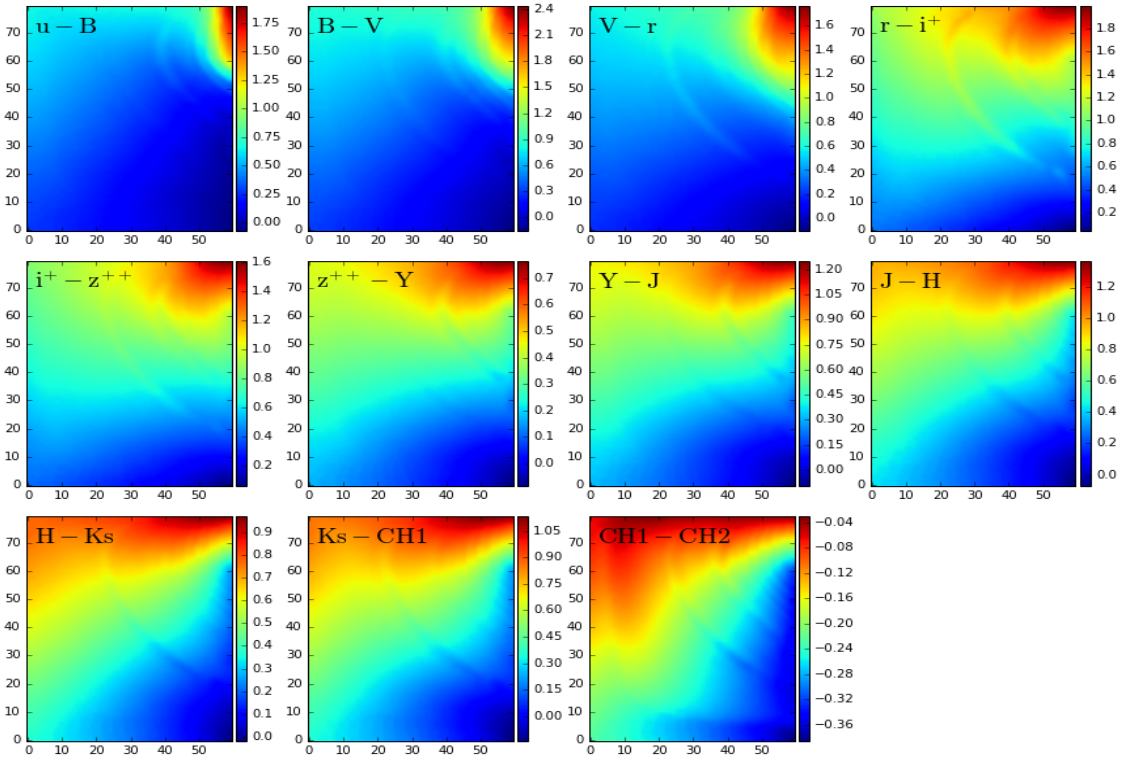
3.8 sqdeg vs 0.2 sqdeg → Cosmic Variance?

Fill in the gaps rather than expanding the color-space.
Increase of sample size, number densities, large scale structure and cosmology.

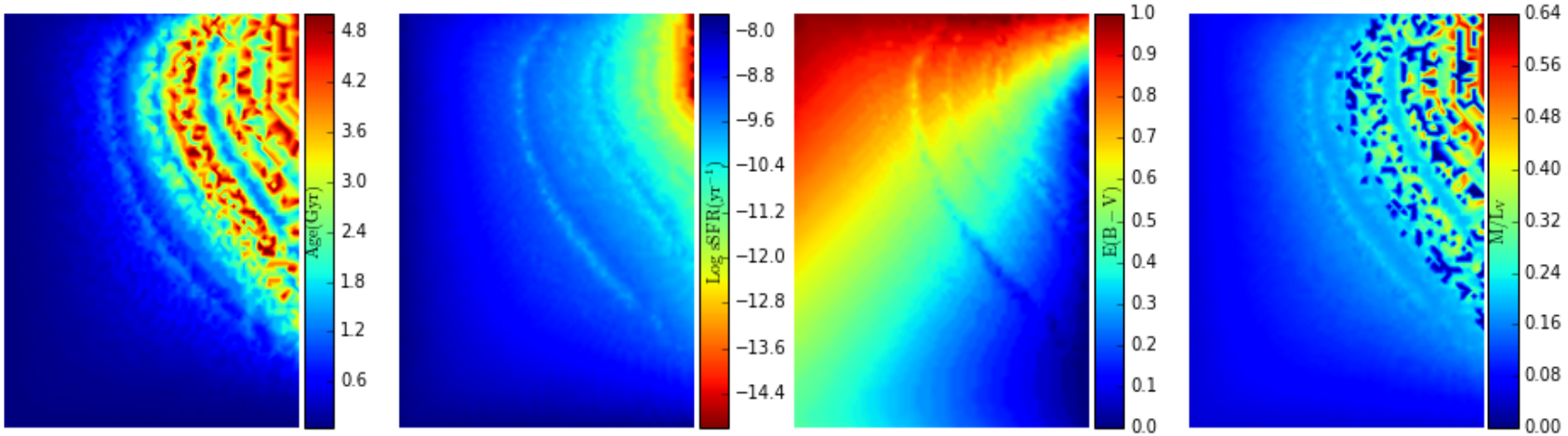
2. Constrain the Parameter space of theoretical libraries

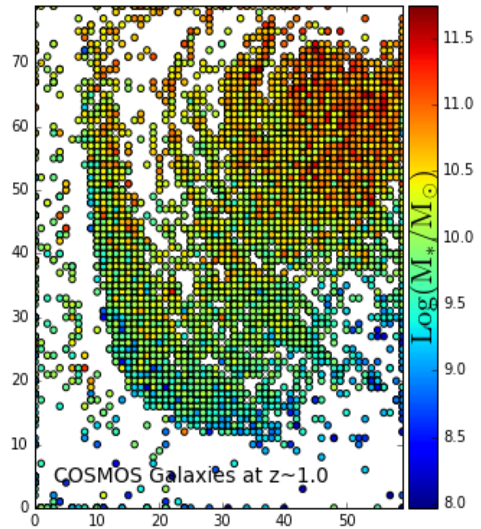
stellar templates	IMF	SFH	$log(\tau/yr)$	metallicity$[Z_\odot]$	$log(age/yr)$	extinction law	E(B-V)
BC03	Chabrier	τ	8.5-10 (0.1)	0.4	7.7-10.0 (0.1)	Calzetti	0.0-1.0 (0.025)

Train the SOM with colors of BC03 model SEDs :



2. Constrain the Parameter space of theoretical libraries





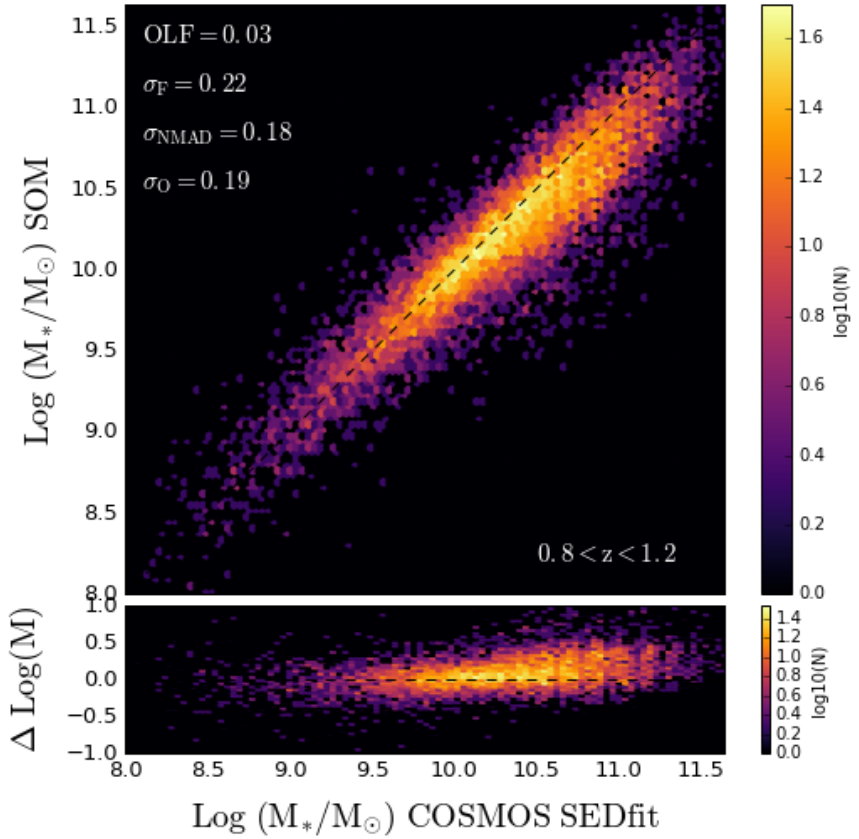
Map observed data to the SOM

Optimize the theoretical library parameter space given observations.

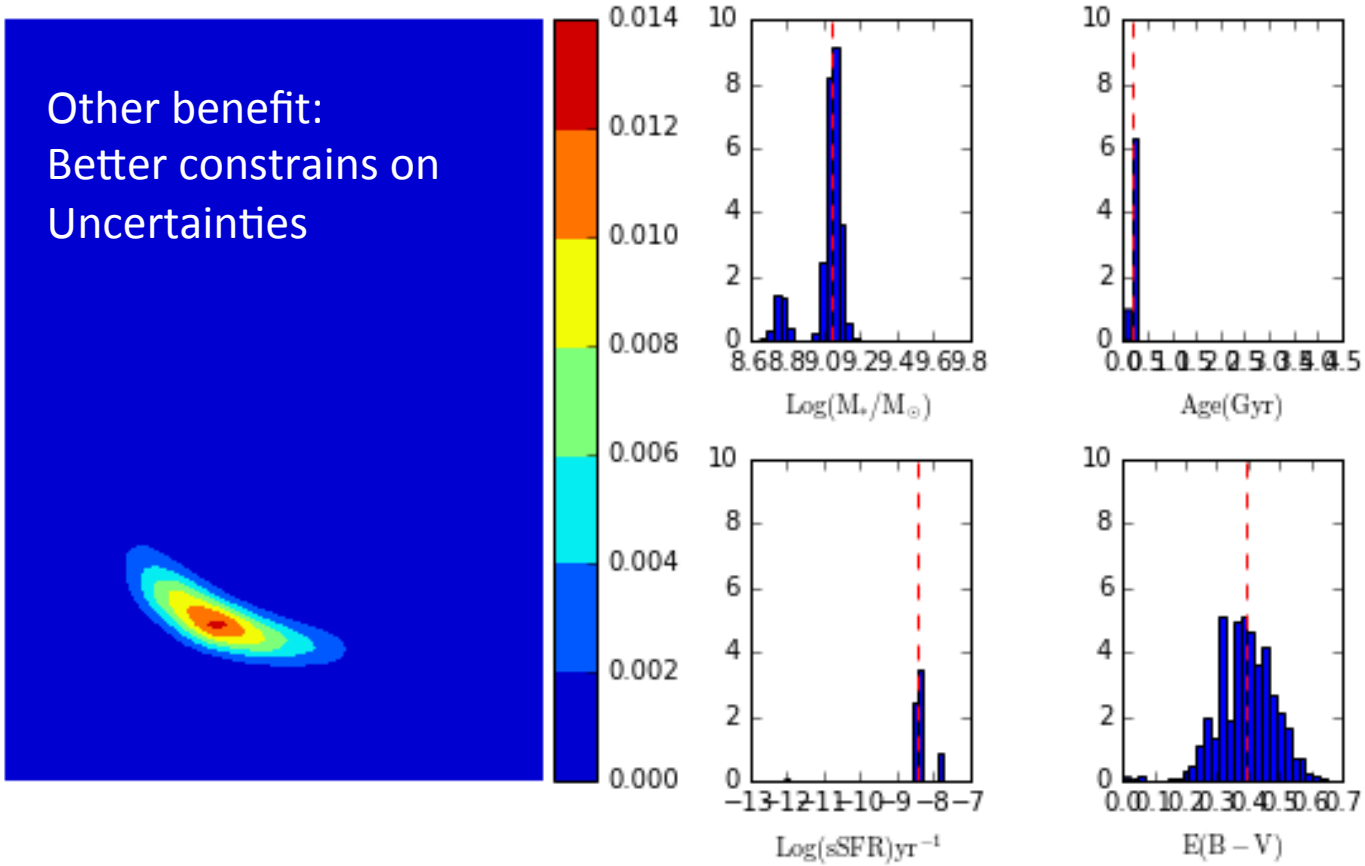
SOM application: Measurement of Physical Properties

Once trained and optimized, mapping of observations to the SOM provides physical parameters of the mapped samples.

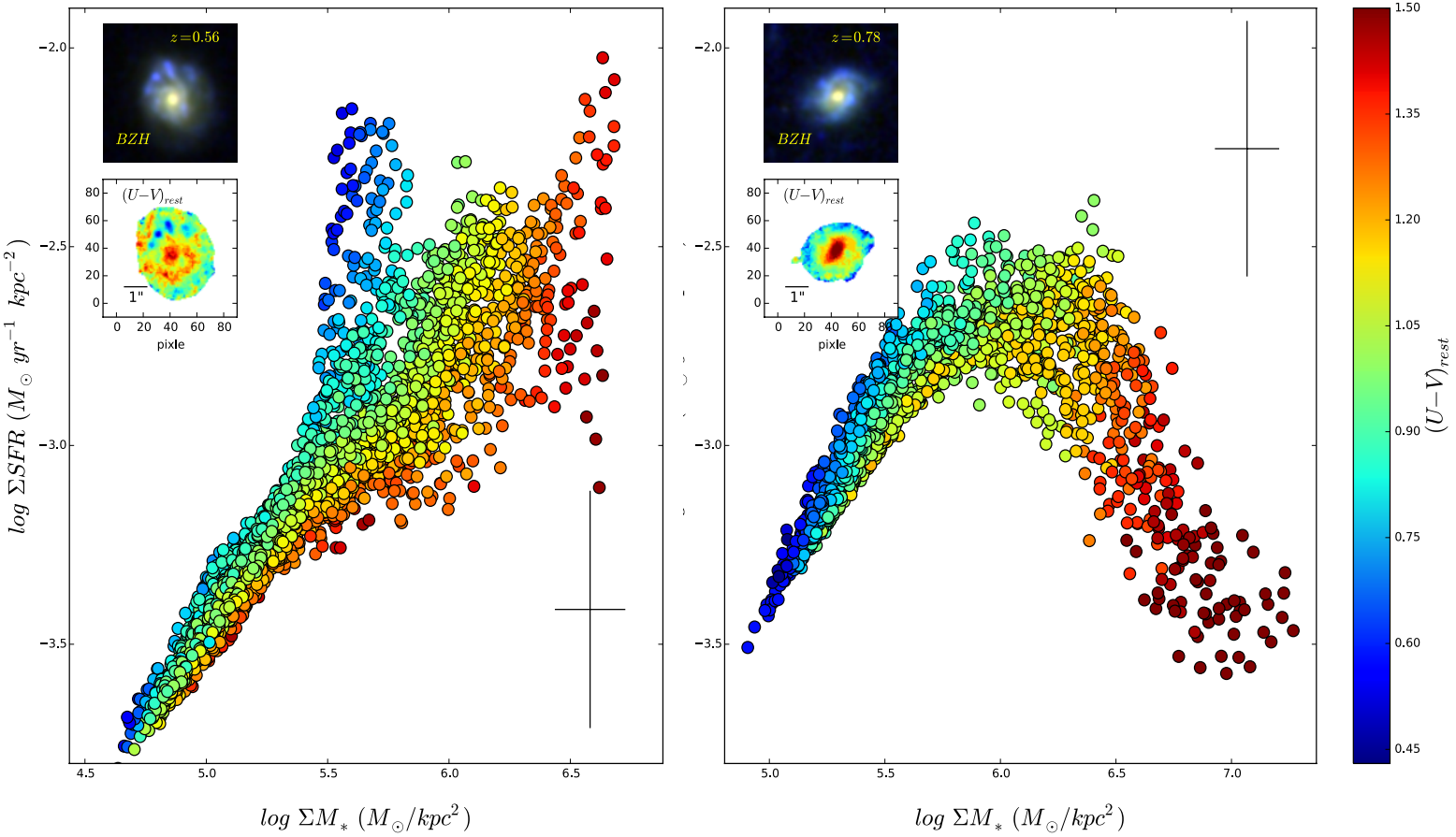
Idea: SED fitting
Benefit : Much faster



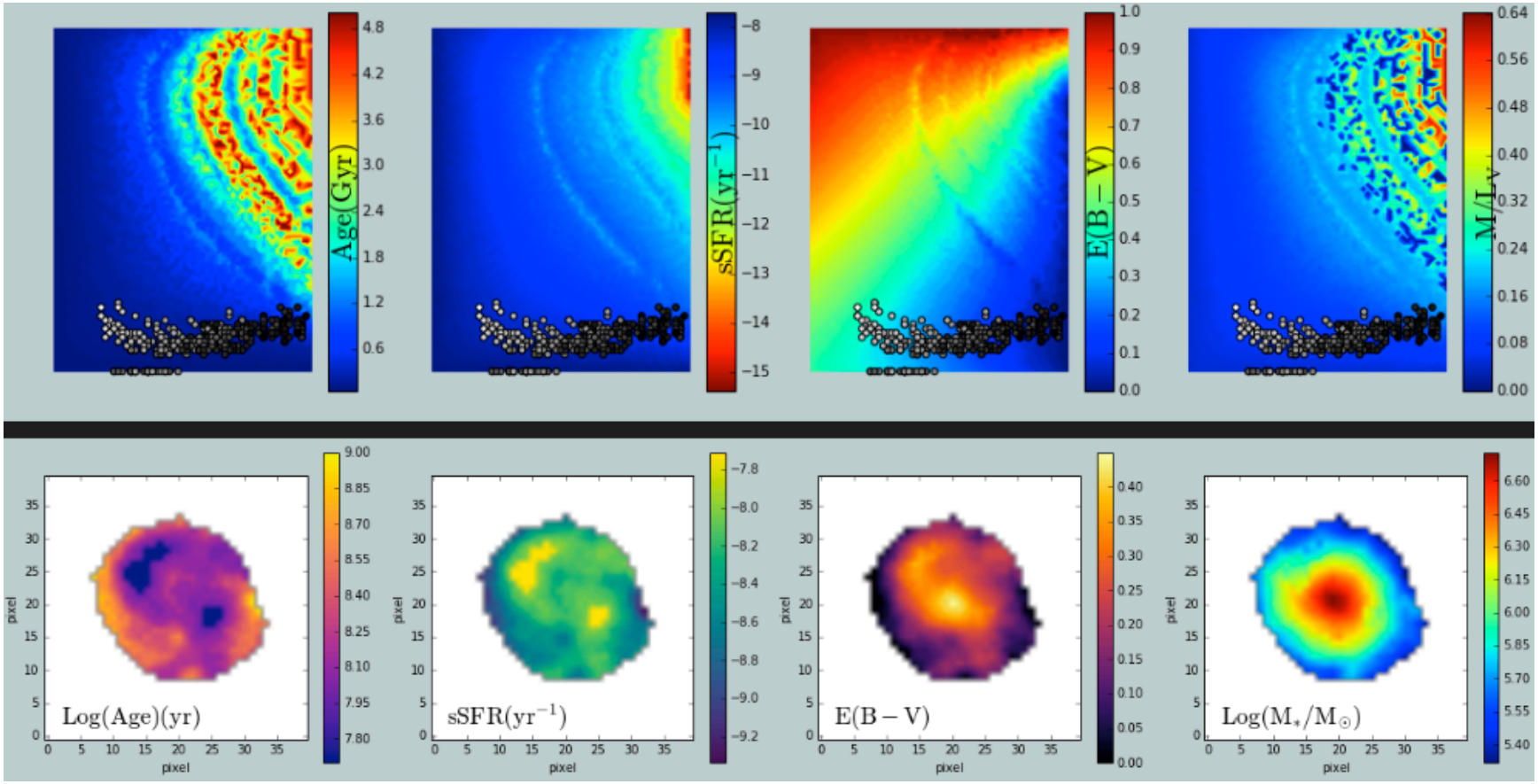
SOM application: Measurement of Physical Properties



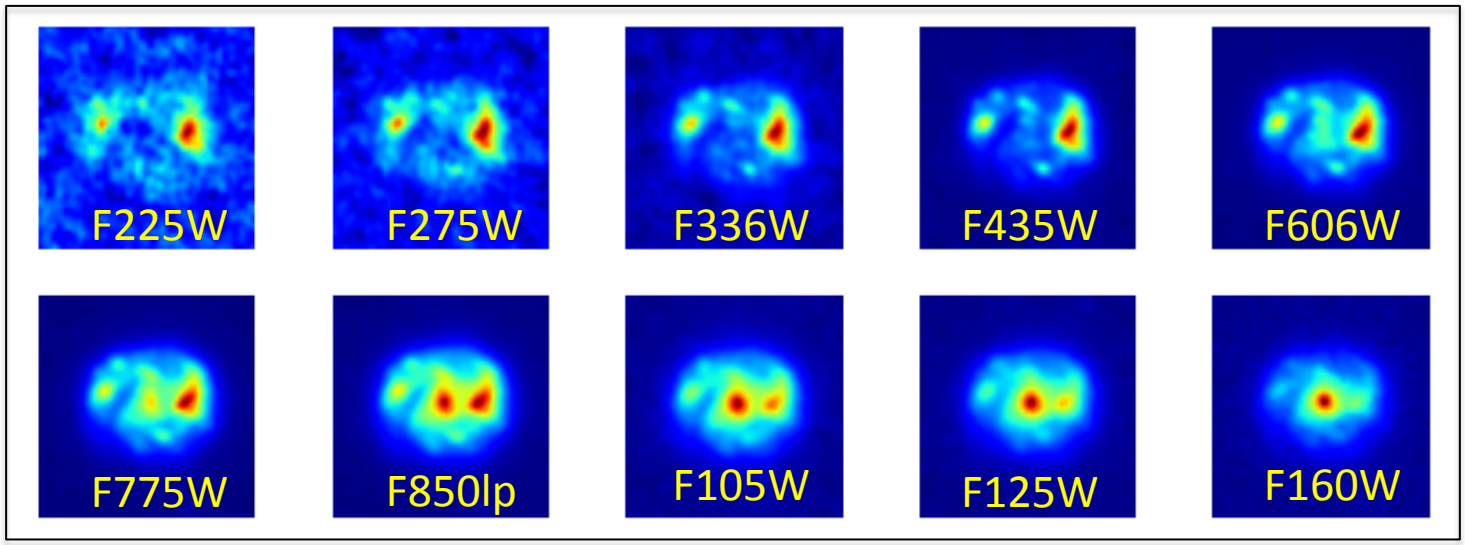
Previously on CANDELS: Resolved main sequence



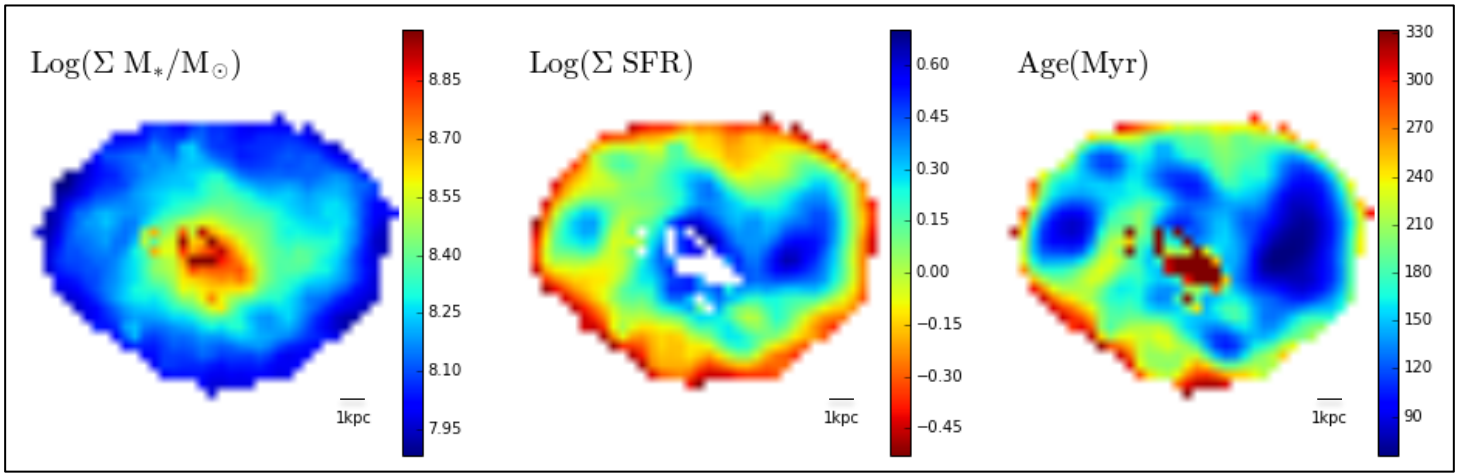
SOM application: Measurement of Physical Properties



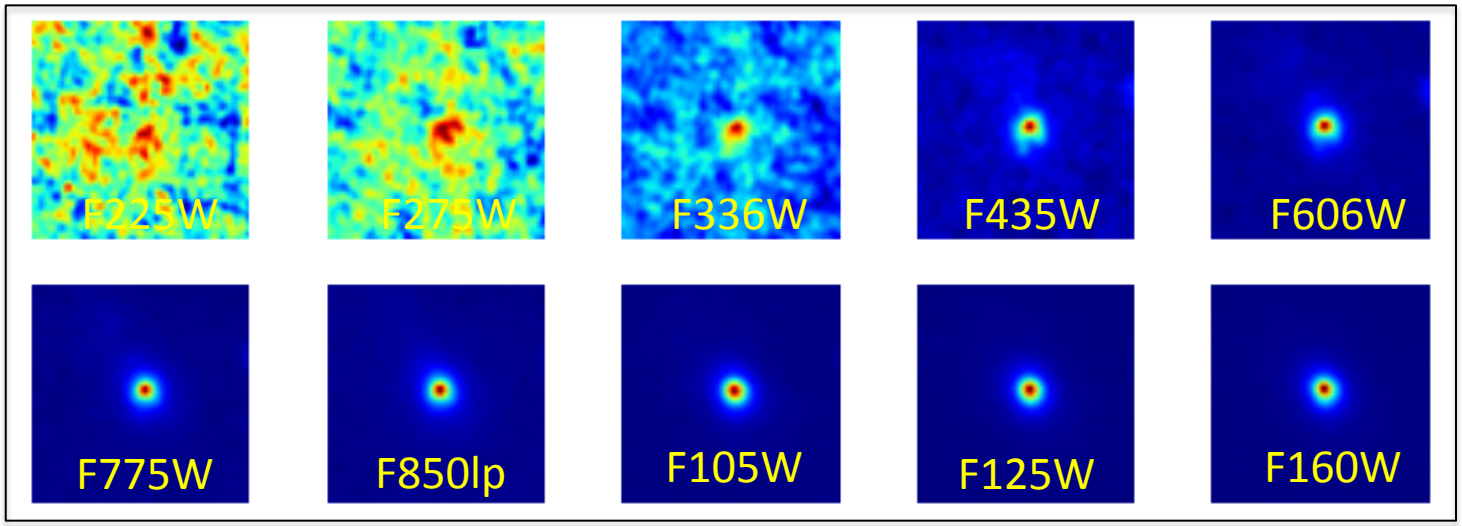
Better Resolved



z = 1
Log M*/Mo = 10.3
SFR = 60 M*/yr



Better Resolved



z = 1
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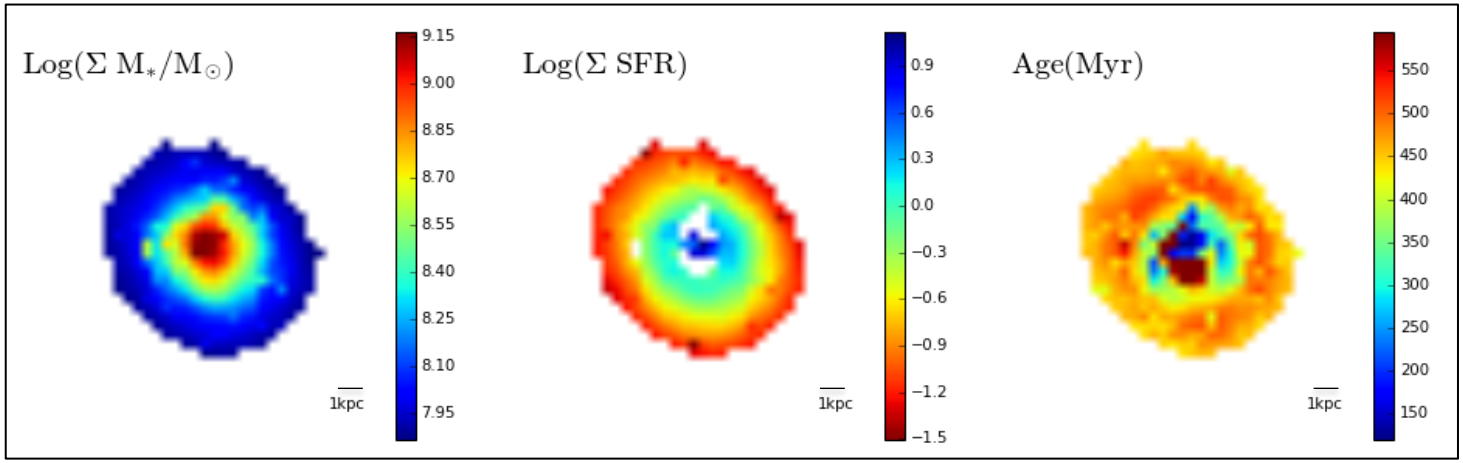
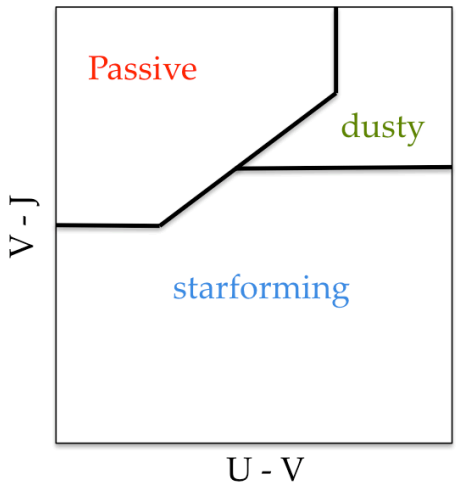
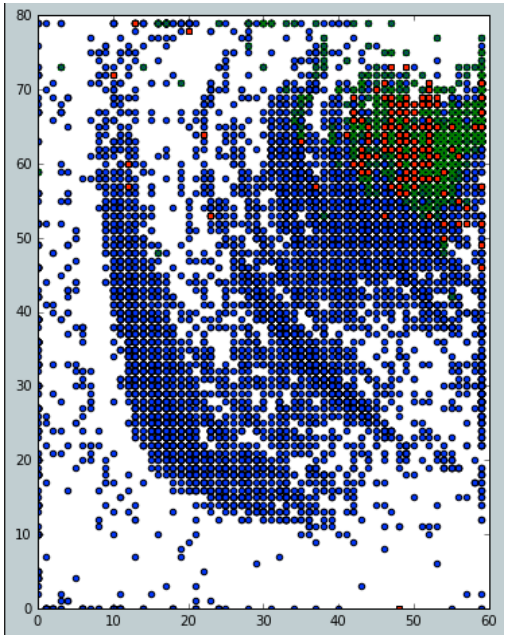
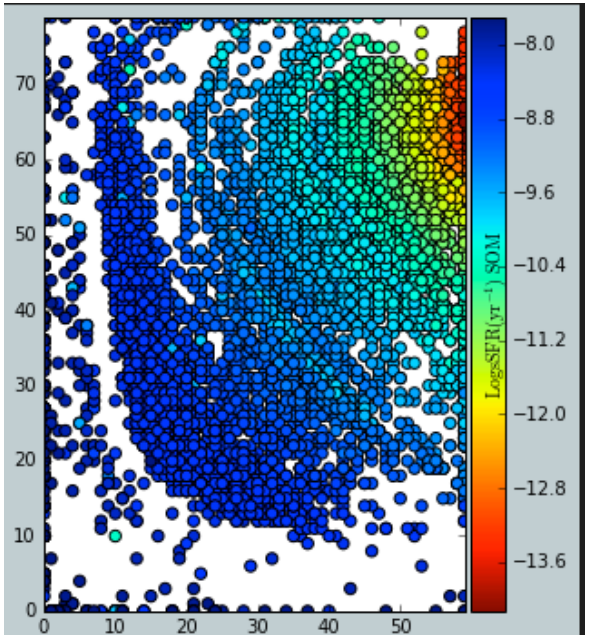
SFR = 1 M*/yr



More applications,
galaxy selections such as the UVJ







Thank you.