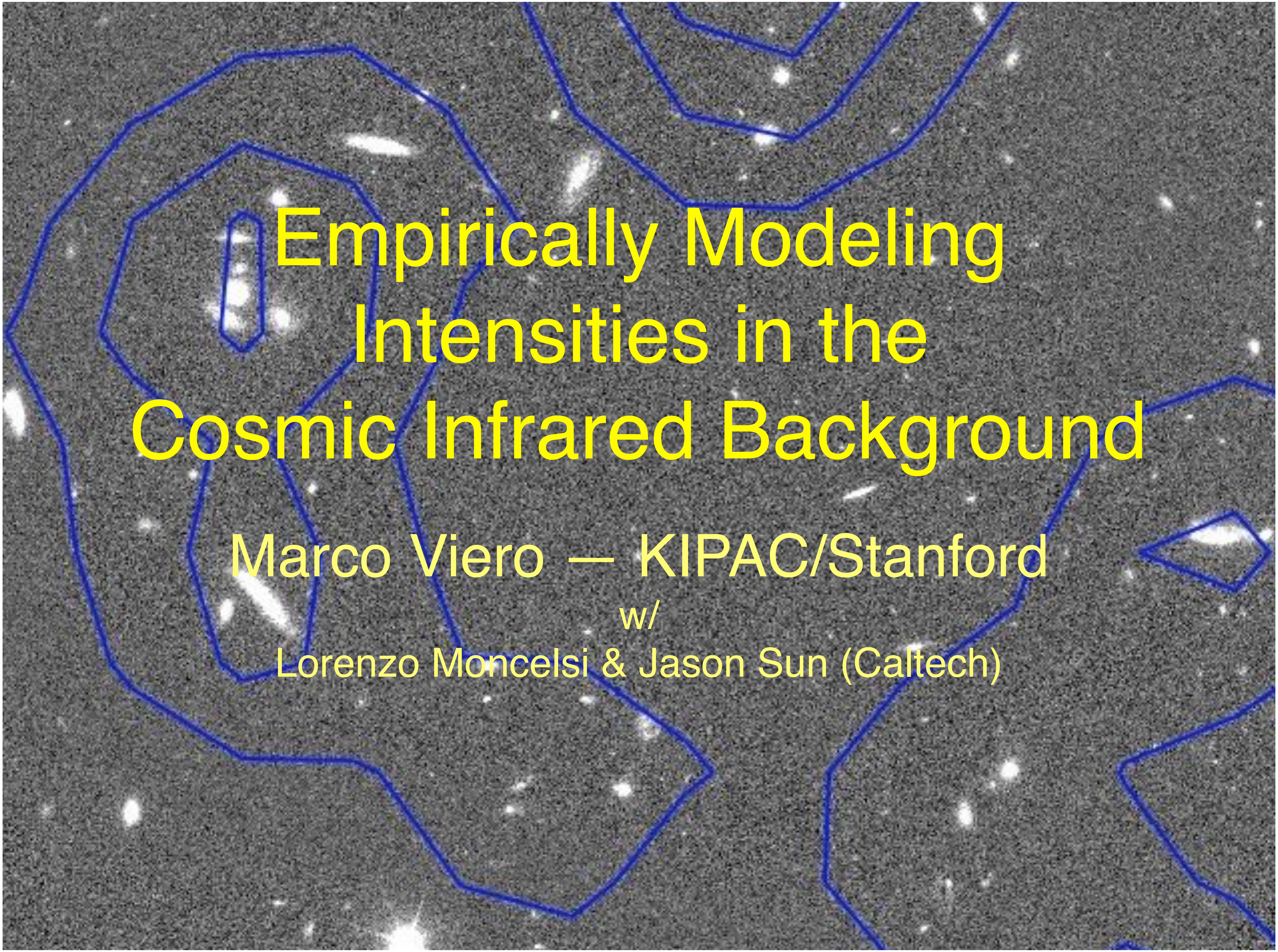
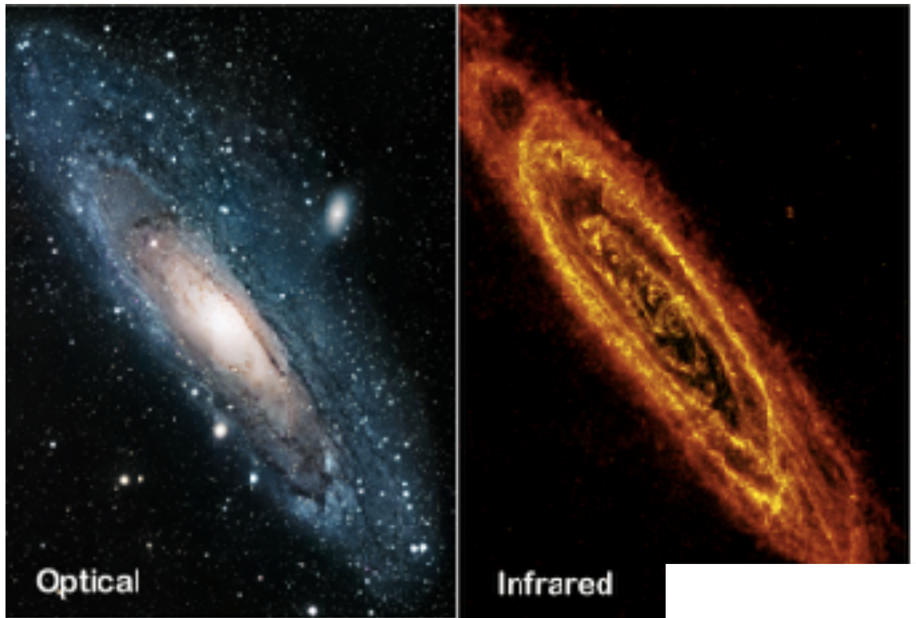


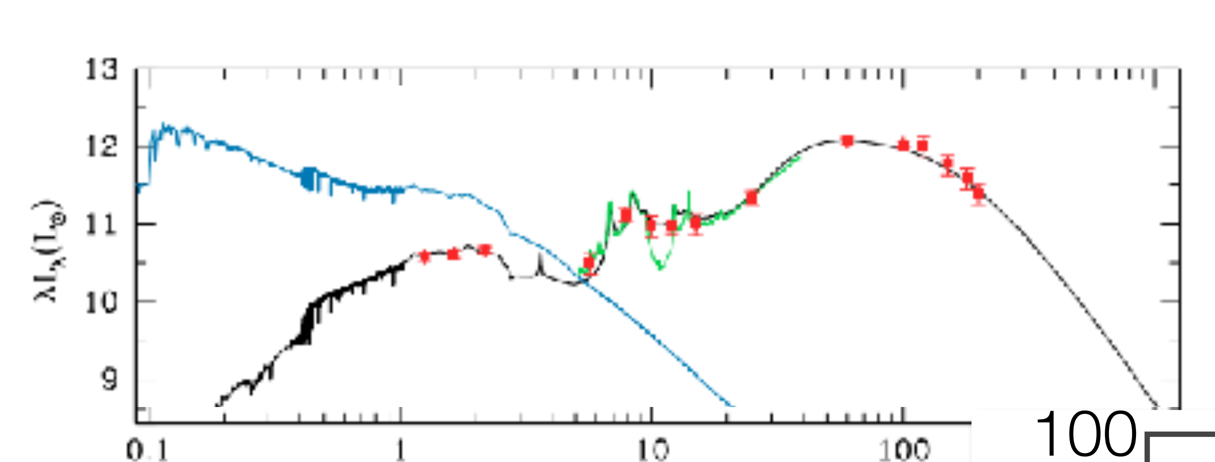
Empirically Modeling Intensities in the Cosmic Infrared Background

Marco Viero — KIPAC/Stanford
w/
Lorenzo Moncelsi & Jason Sun (Caltech)

Motivation

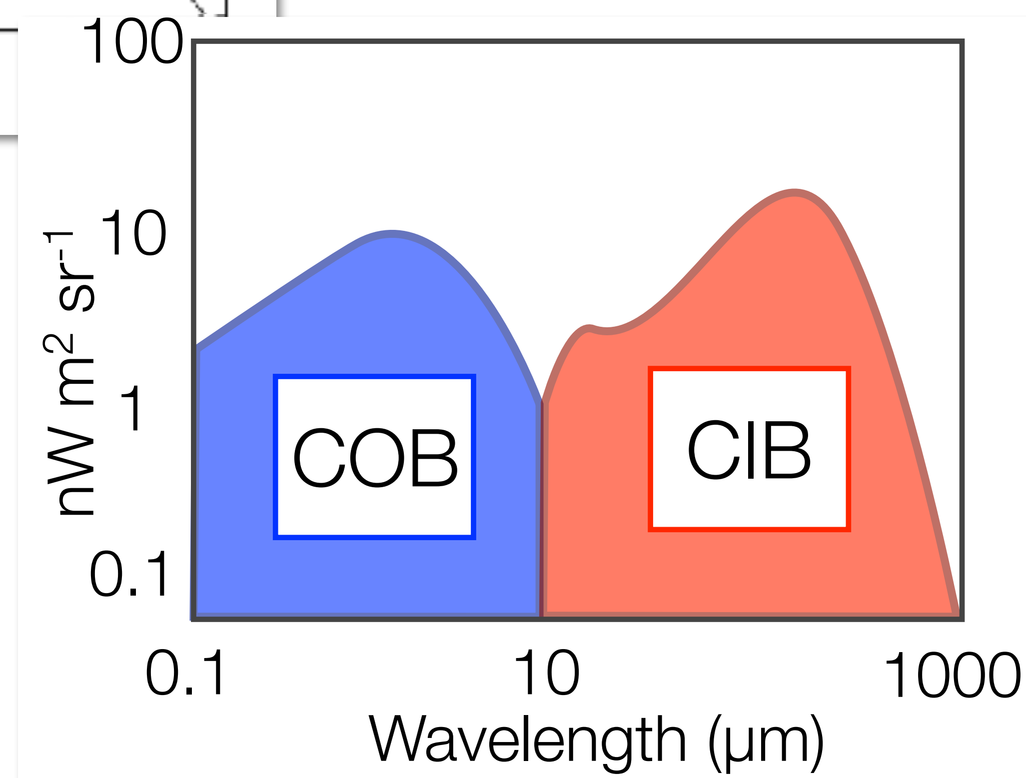


- Infrared/Submillimeter emission reprocessed starlight by dust
- IR/Submm traces star formation
- Half the emission is tied up in dust

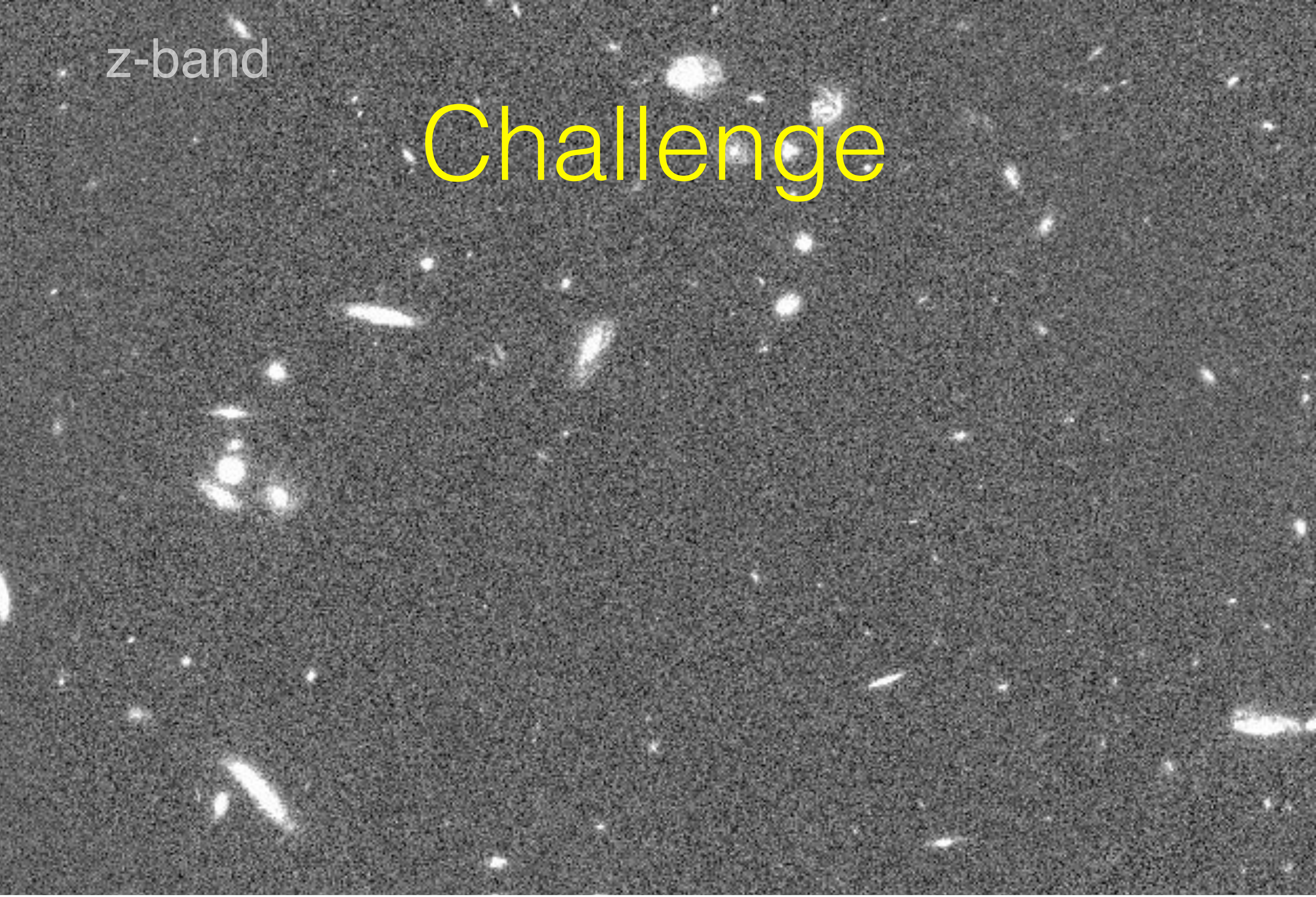


da Cunha+2010

- Want to know:
  - ➡ the full SED (including IR) of all galaxies
  - ➡ accurate characterization of secondary anisotropies



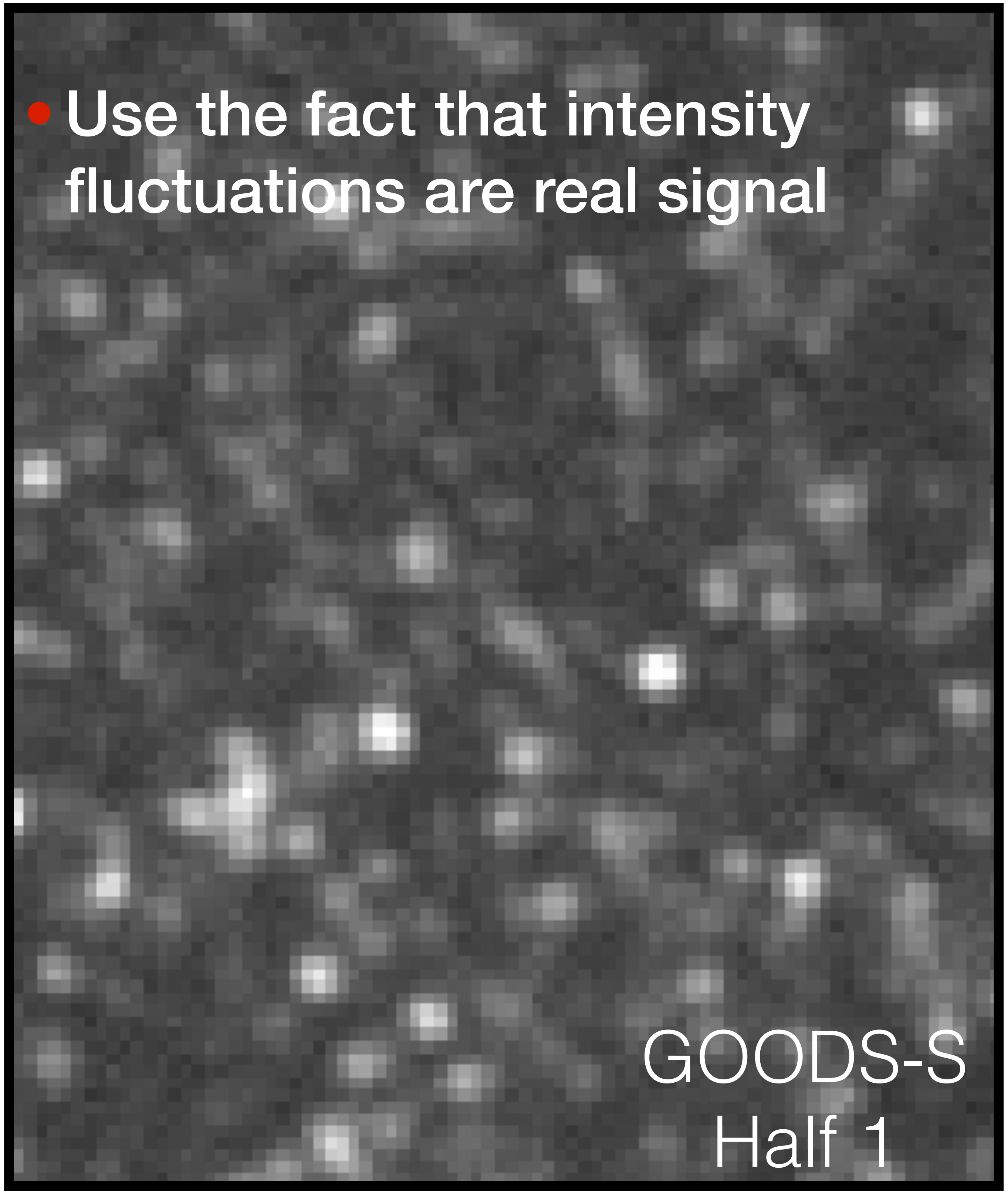
Challenge

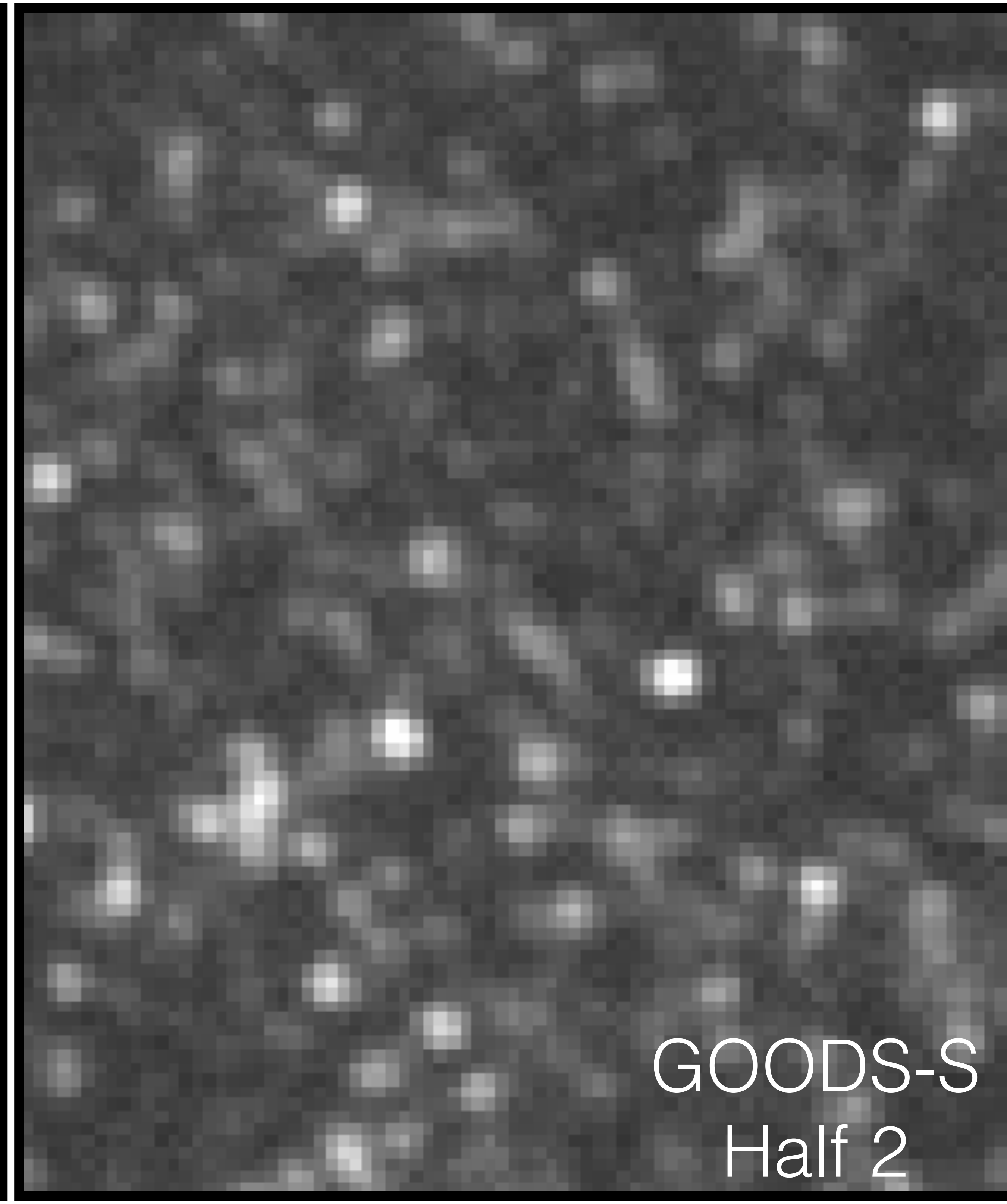


Solution

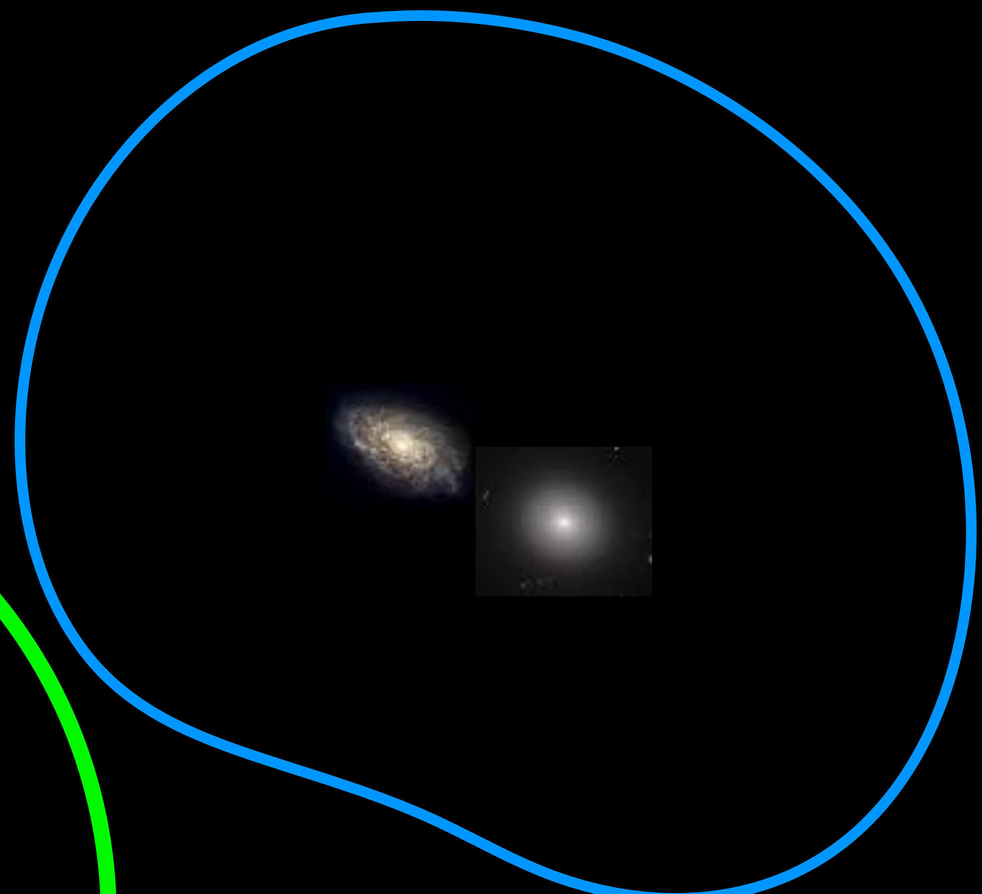
- Treat images as a continuum intensity maps
- Use ancillary data
- Get creative

- Use the fact that intensity fluctuations are real signal

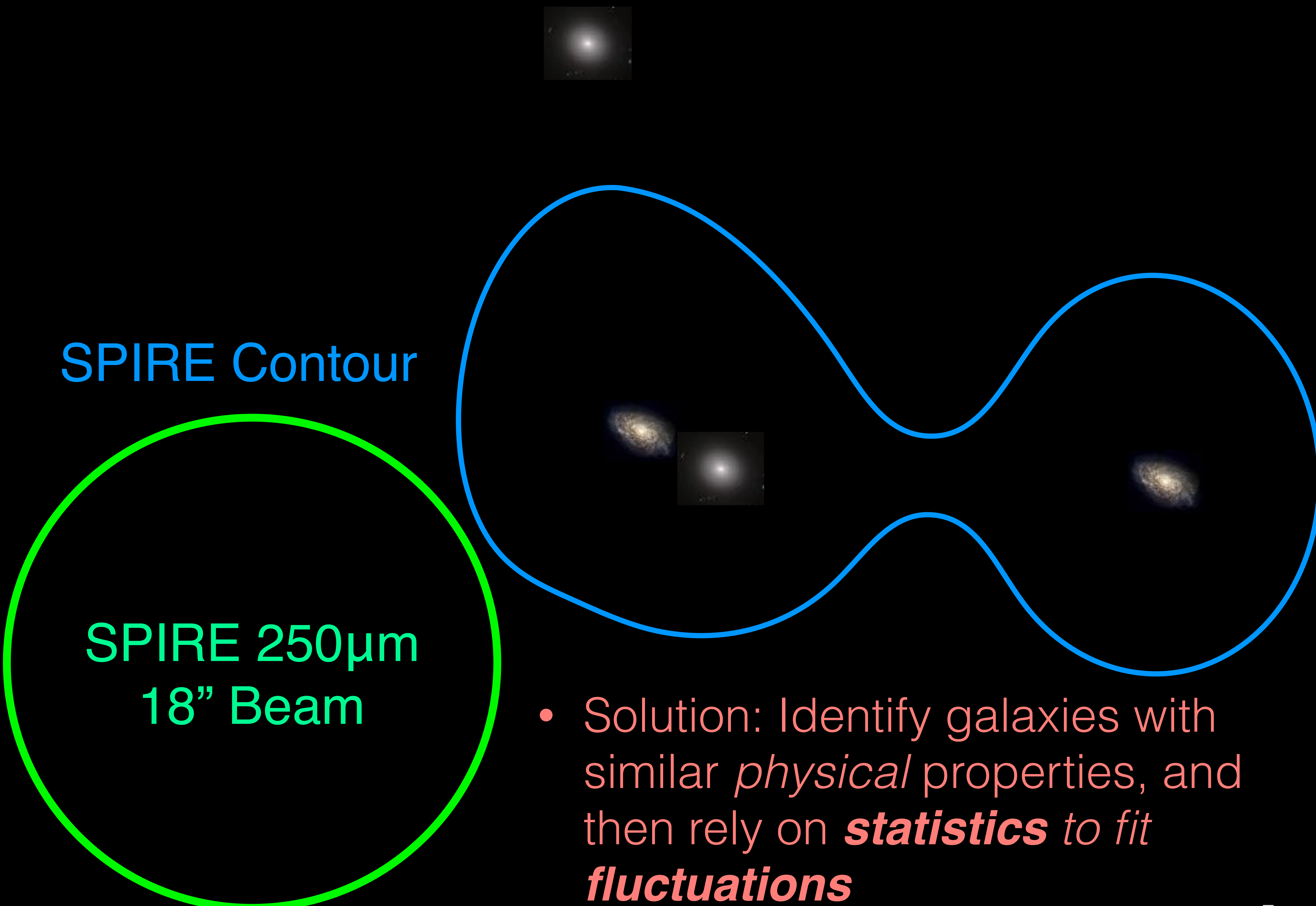




SPIRE Contour



- Challenge: Difficult to attribute an individual submillimeter “source” to any single galaxy



- Solution: Identify galaxies with similar *physical* properties, and then rely on ***statistics*** *to fit* ***fluctuations***

Assumptions

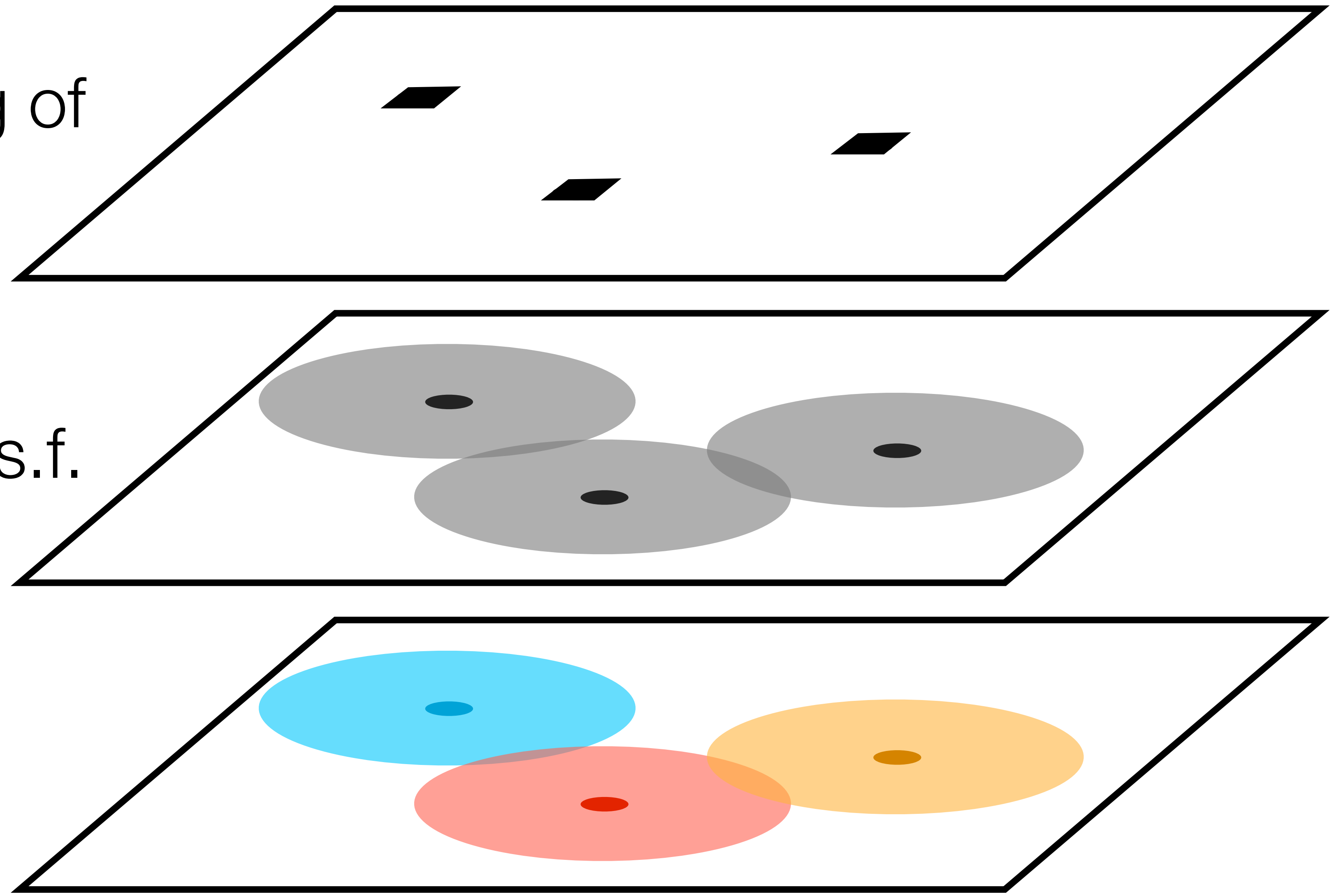
- Galaxies identified as “similar” will have similar FIR properties
- Catalog is reasonably complete (that’s *another* talk)
- [note: outliers (e.g., lensed galaxies) are ignored]

SIMSTACK: Continuum Intensity Fitting Algorithm

make hits map from catalog of similar objects

convolve with instrument p.s.f.

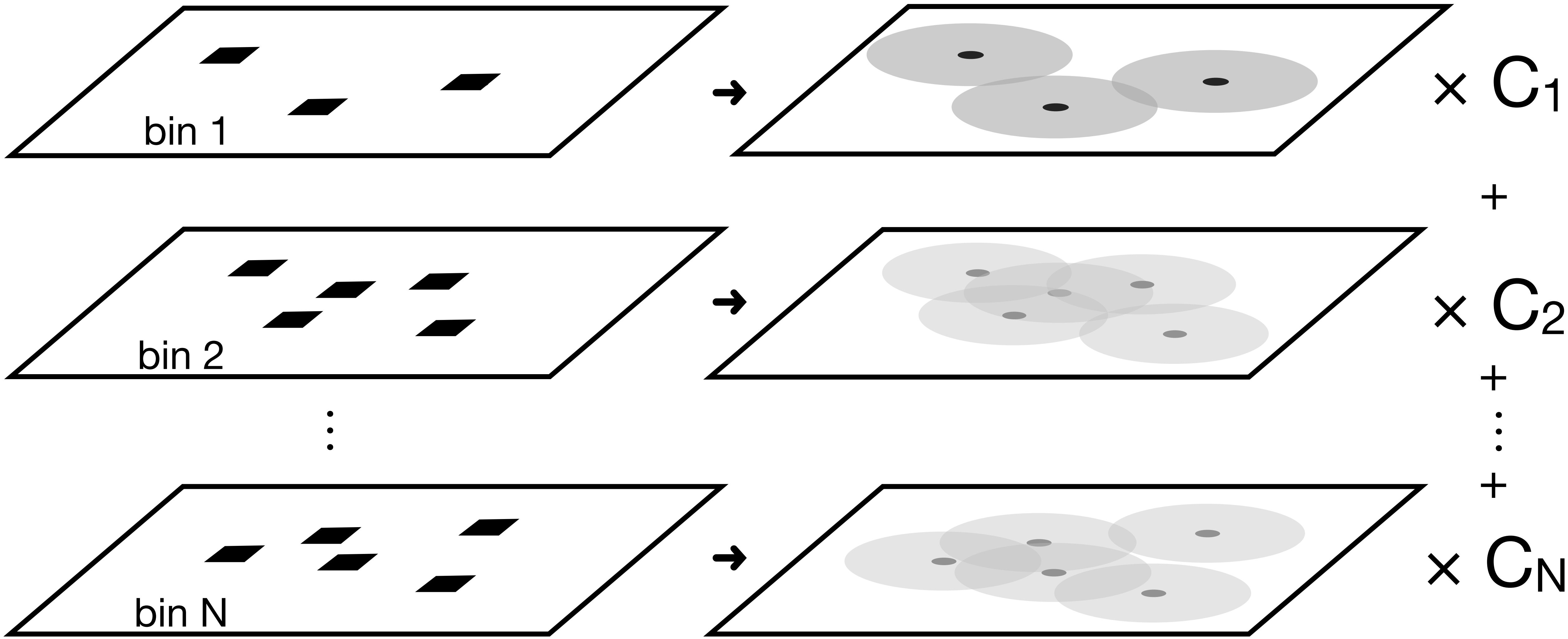
regress to find *mean* flux density

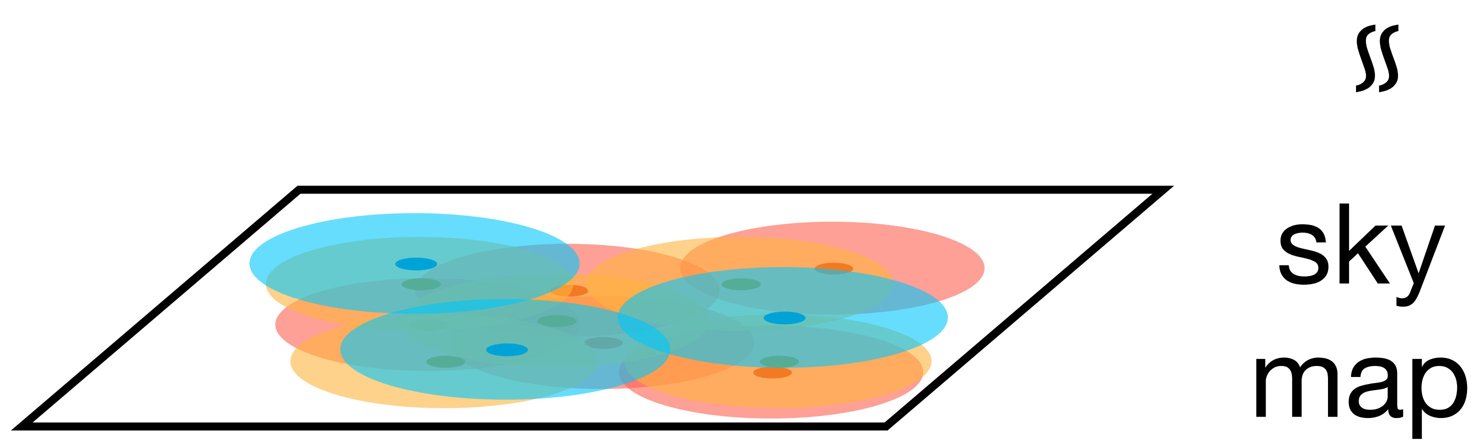


Formalism developed w/ Lorenzo Moncelsi (Caltech);
also see Kurczynski & Gawiser (2010), Roseboom et al. (2010)

SIMSTACK code publicly available (see arXiv:1304.0446):
IDL (old) — https://web.stanford.edu/~viero/downloads.html
Python (under development!) — https://github.com/marcoviero/simstack

SIMSTACK: Continuum Intensity Fitting Algorithm

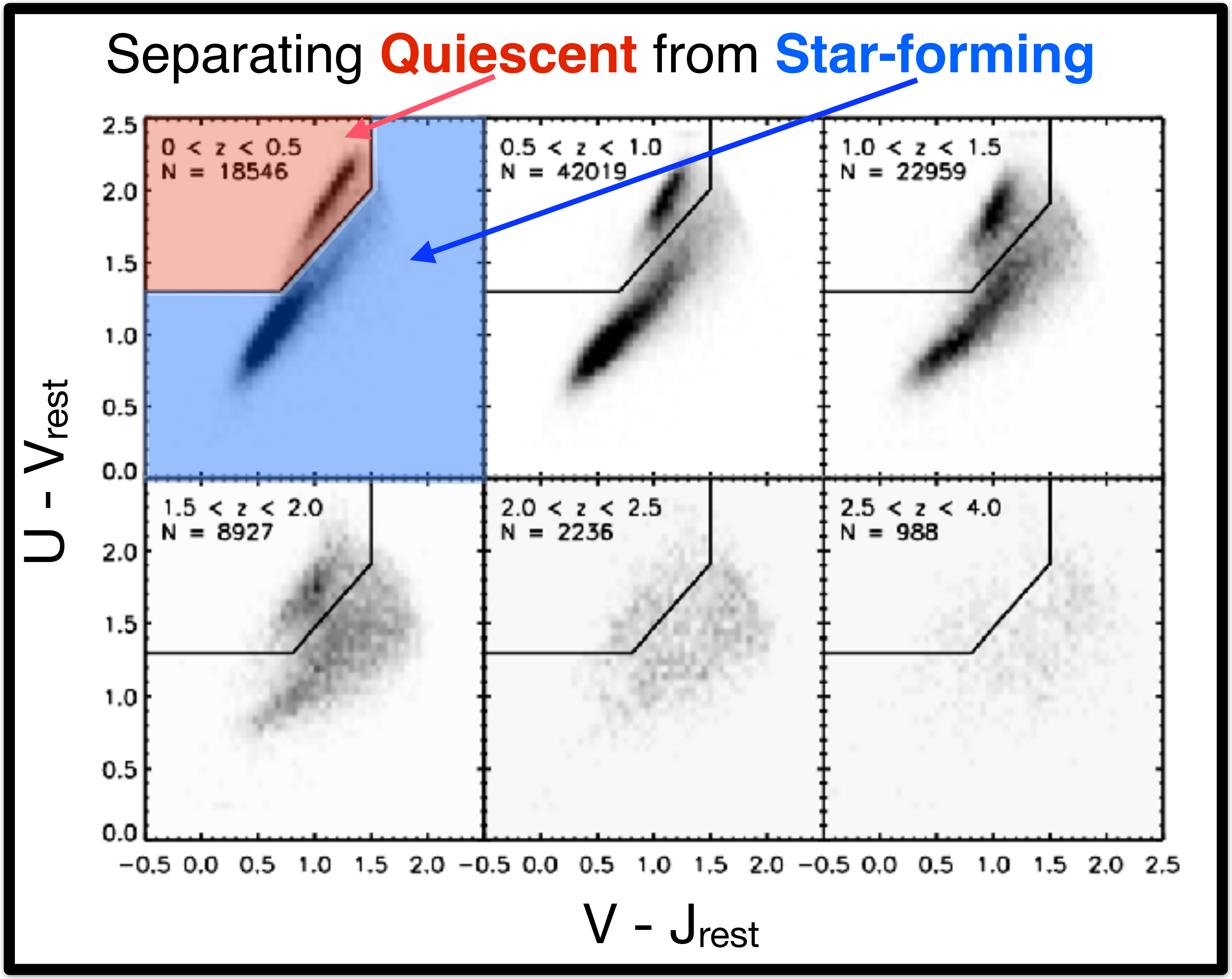




Formalism developed w/ Lorenzo Moncelsi (Caltech)

SIMSTACK code publicly available (see arXiv:1304.0446):
Python (under development!) — https://github.com/marcoviero/simstack

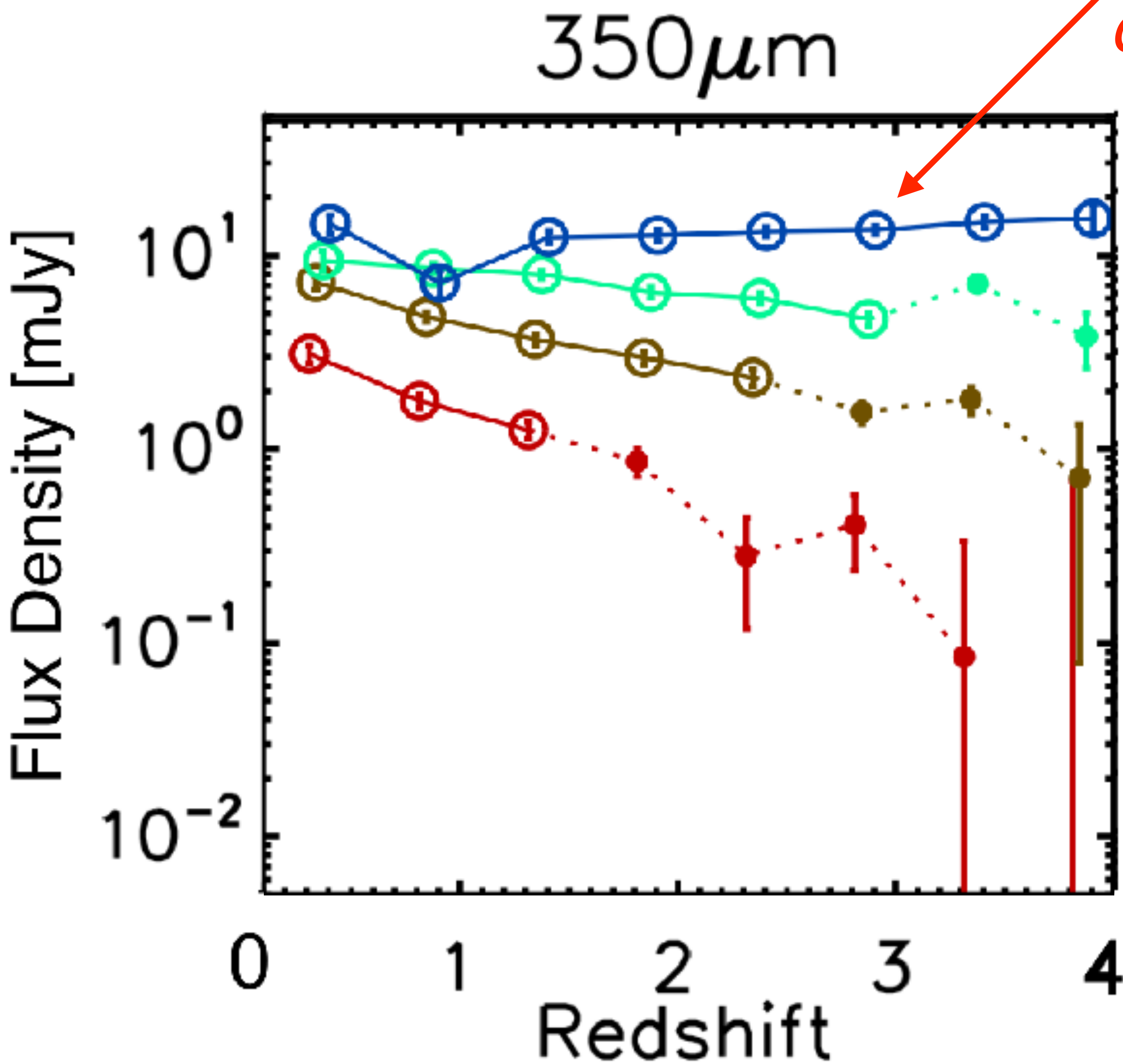
SIMSTACK: Simple E.g. of Catalog Splits



- **Redshifts** - EAZY (Brammer 2008)
- **Masses** - FAST (Kriek 2009)
- **Colors** - UVJ (Williams 2009)

Muzzin et al. (2013)

SIMSTACK: Flux Densities (M,z)

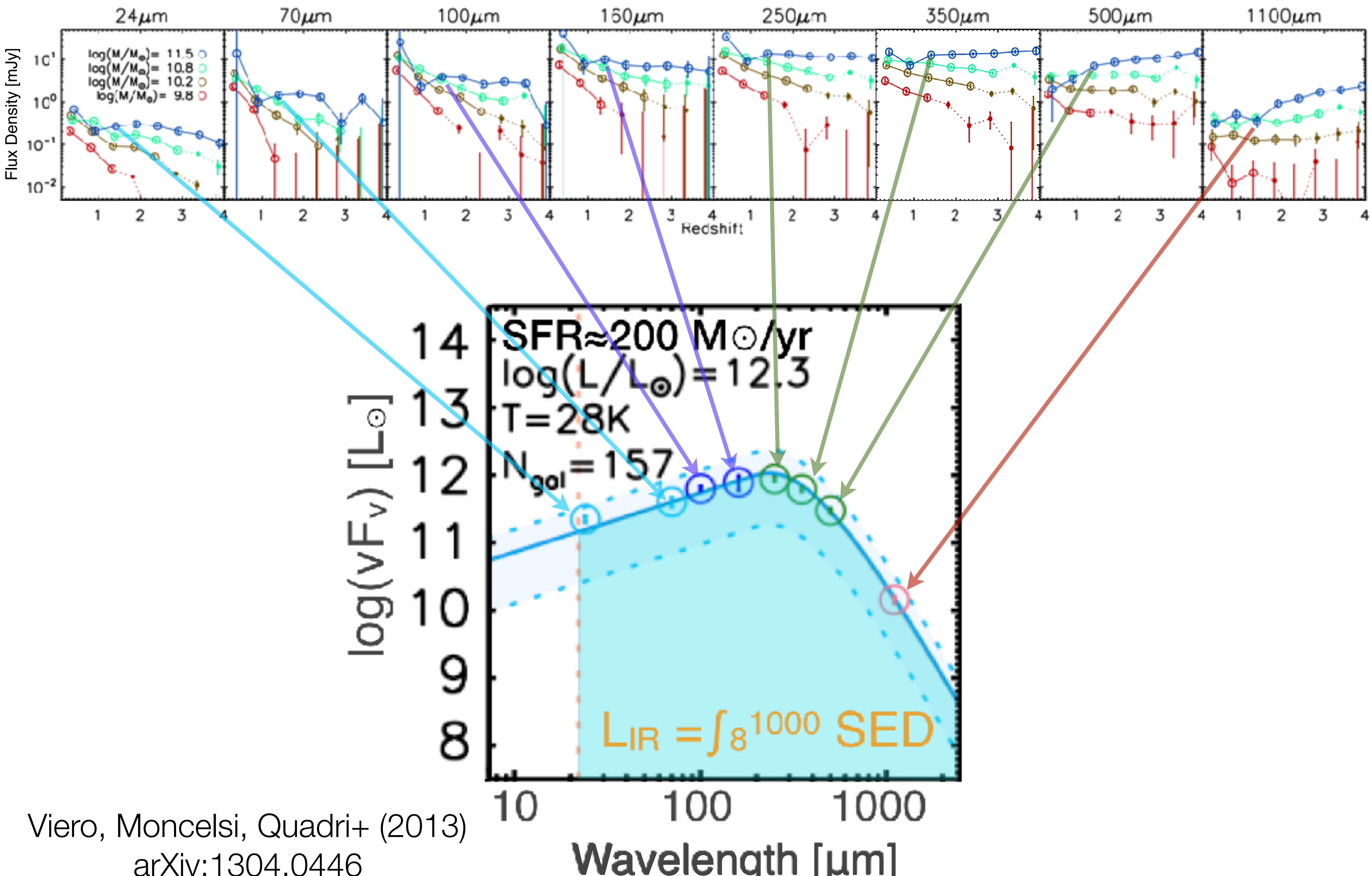


Each circle one bin

Data here:
UDS catalog
&
Herschel
SPIRE maps

SIMSTACK: Flux Densities (M,z)

HERMES

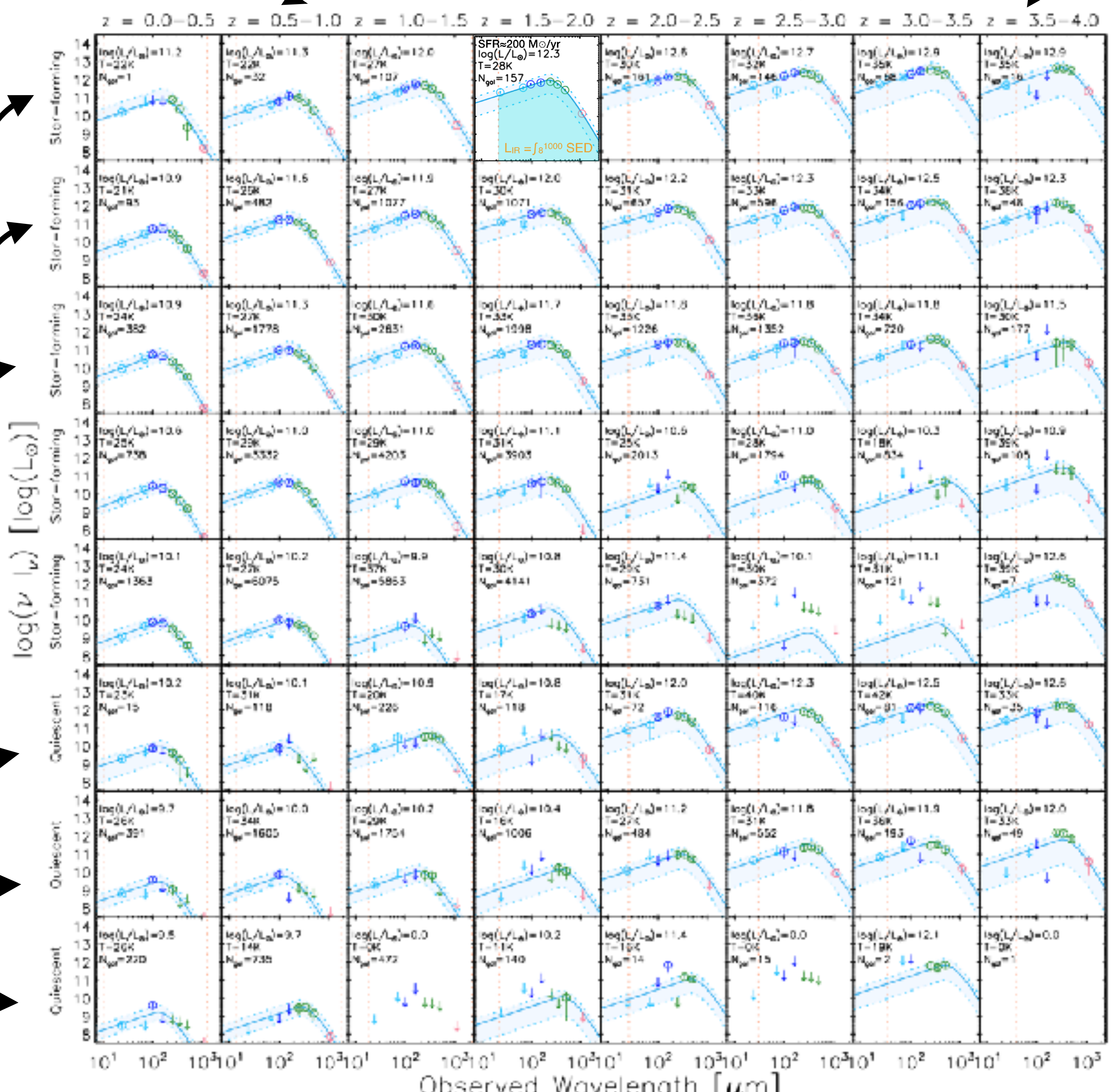


Viero, Moncelsi, Quadri+ (2013)
arXiv:1304.0446

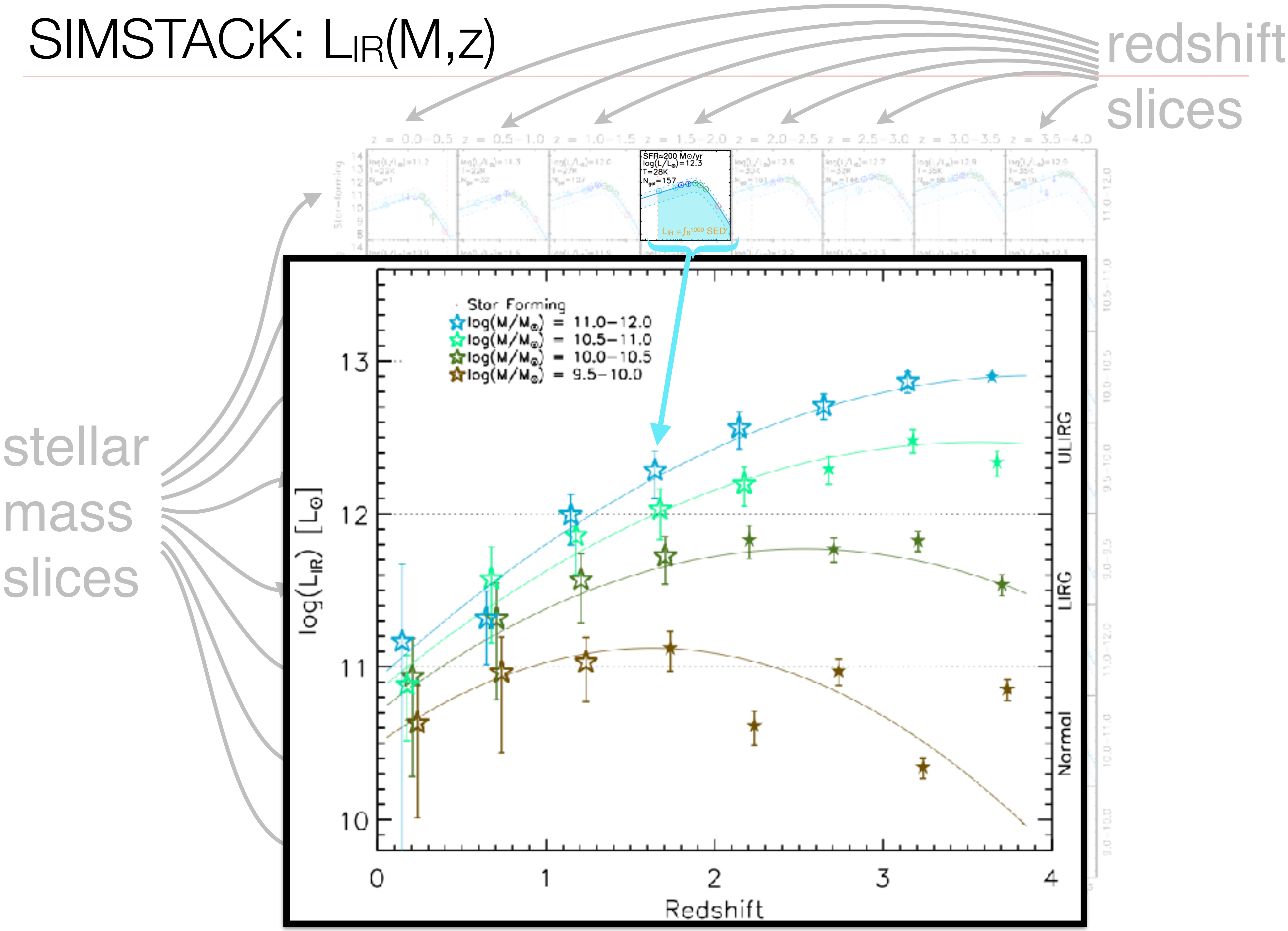
SIMSTACK: SEDs

redshift slices

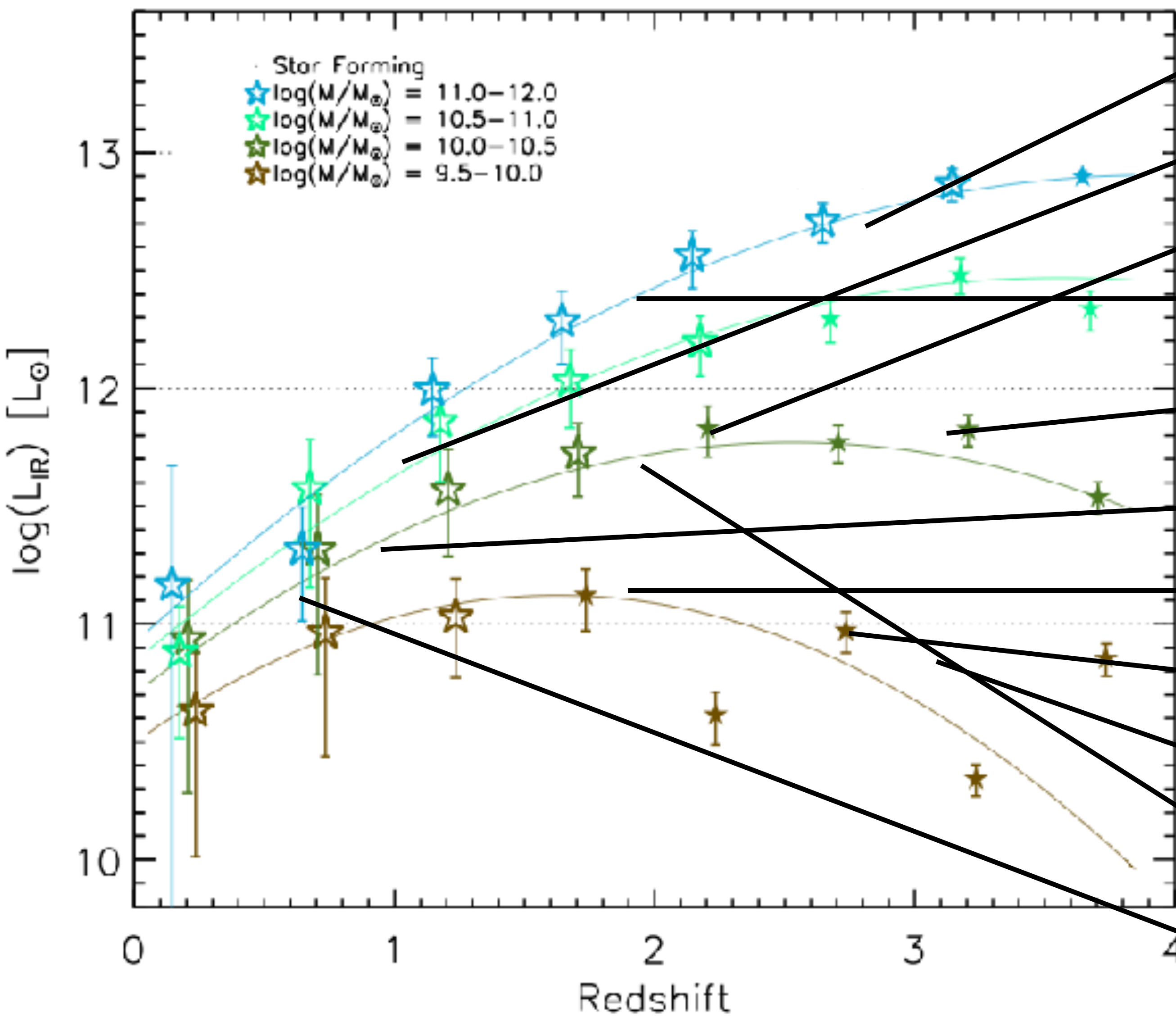
stellar mass slices



SIMSTACK: L_{IR}(M,z)



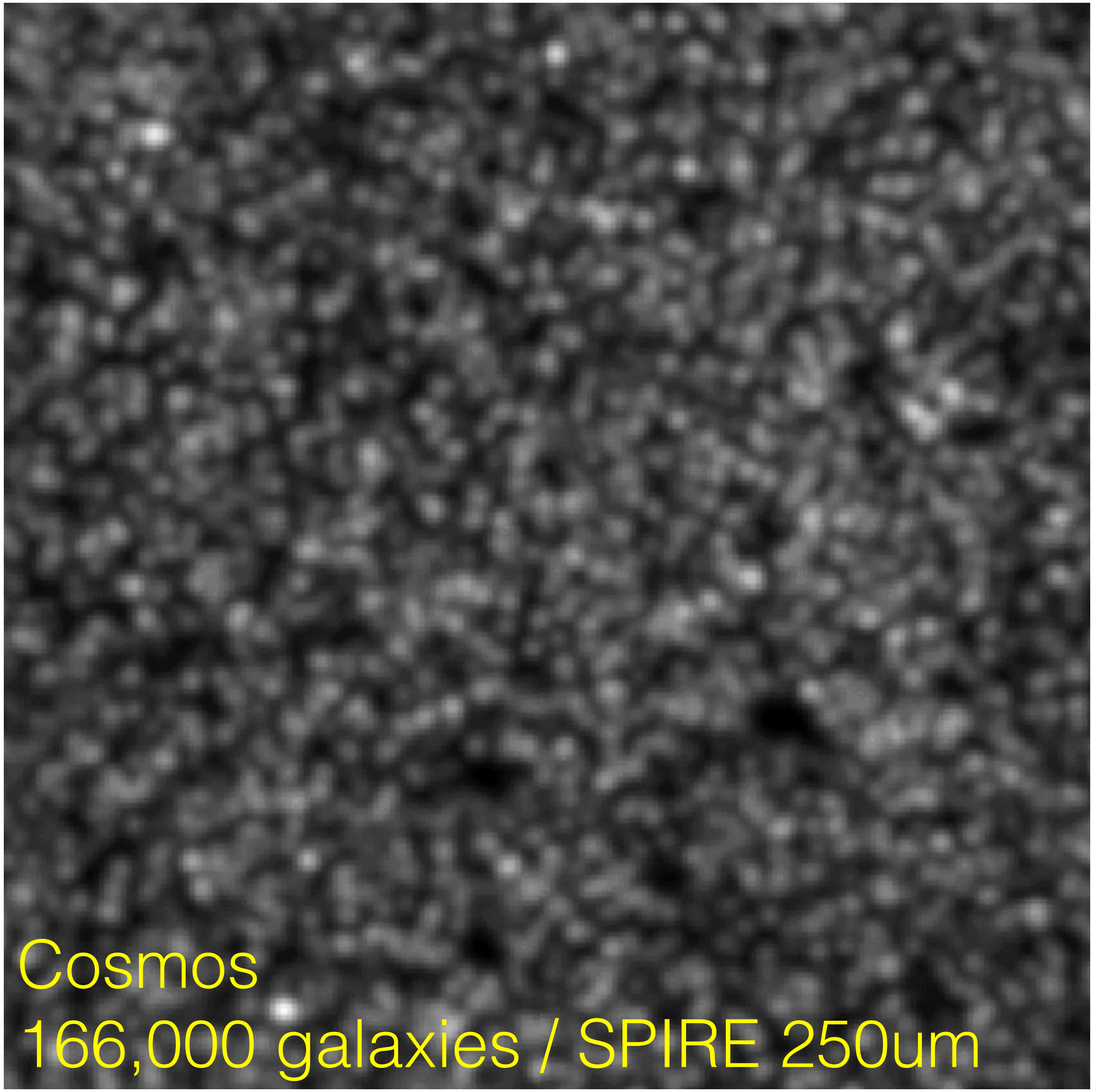
Simulating the Sky



Flux	RA	DEC
41.4	149.853	2.608
3.5	149.854	2.258
4.4	149.752	2.584
16.7	149.832	2.724
22.5	149.275	2.196
3.6	149.262	2.966
5.8	149.915	2.206
3.1	149.546	2.564
2.3	149.824	2.047
4.0	149.453	2.278
2.1	149.863	2.788
…	…	…

Viero, Moncelsi, Quadri et al. (2013)
arXiv:1304.0446

SIMSTACK: simplest results



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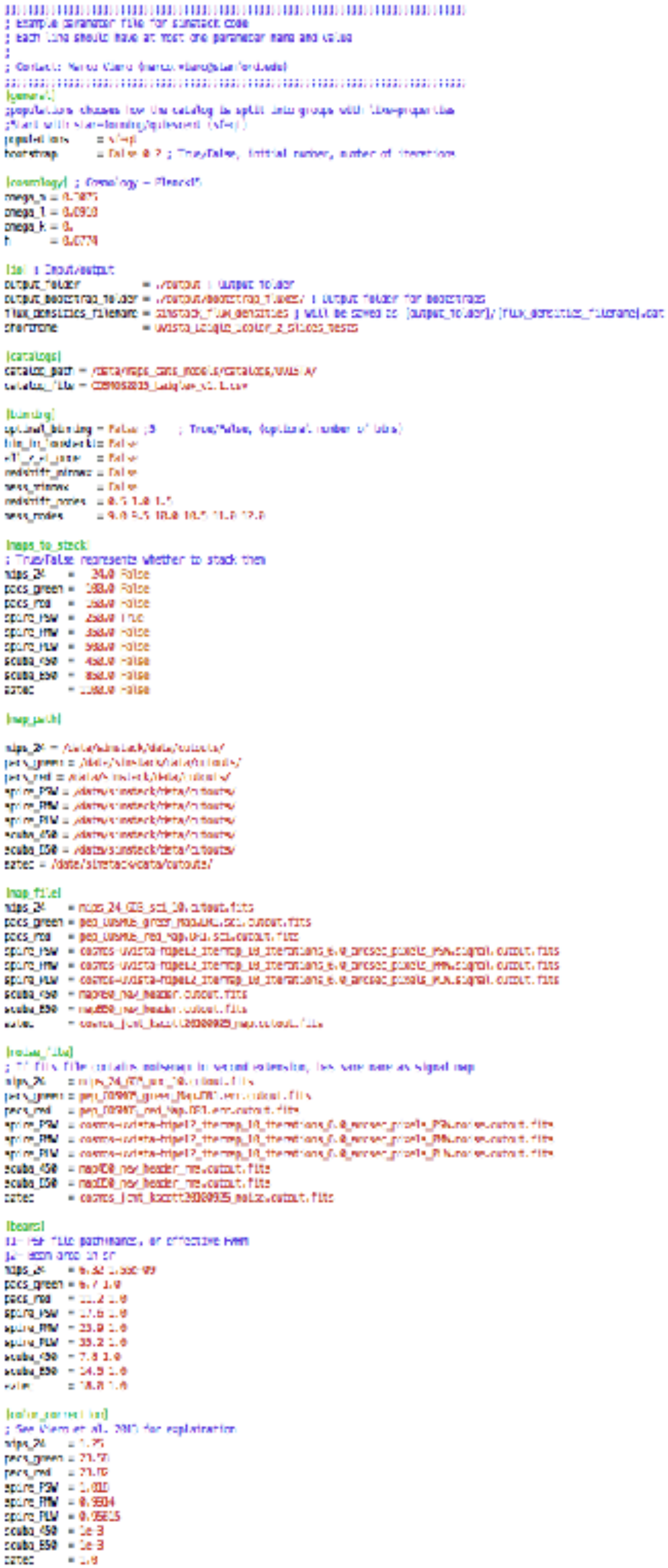


Simstack on Github

Python (under development!) :
https://github.com/marcoviero/simstack

- Just added:
  - Simstack from the command line
  - Edit the **.cfg** parameter file and run:

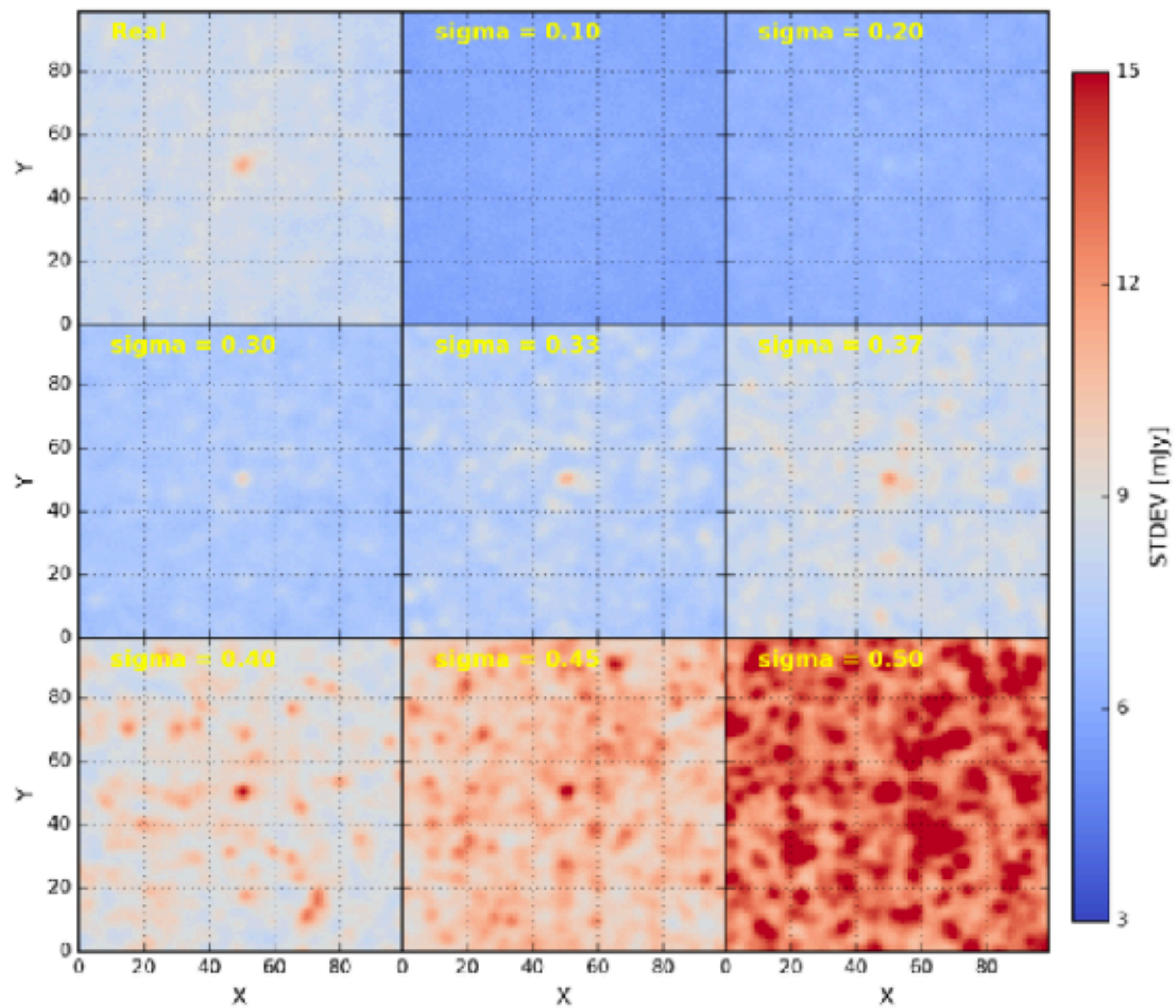
```
../run_simstack_cmd_line.py example.cfg
```

- Flexible. Can:
  - Toggle wavelengths
  - Bootstrap
  - Optimal binning (under developement)

Quantifying Scatter with Simulations

- “Scatter” vs. Scatter:
  -intrinsic vs. lazy split of parent catalog

- Consequences for:
  -guiding masking strategies
  -interpreting power spectrum

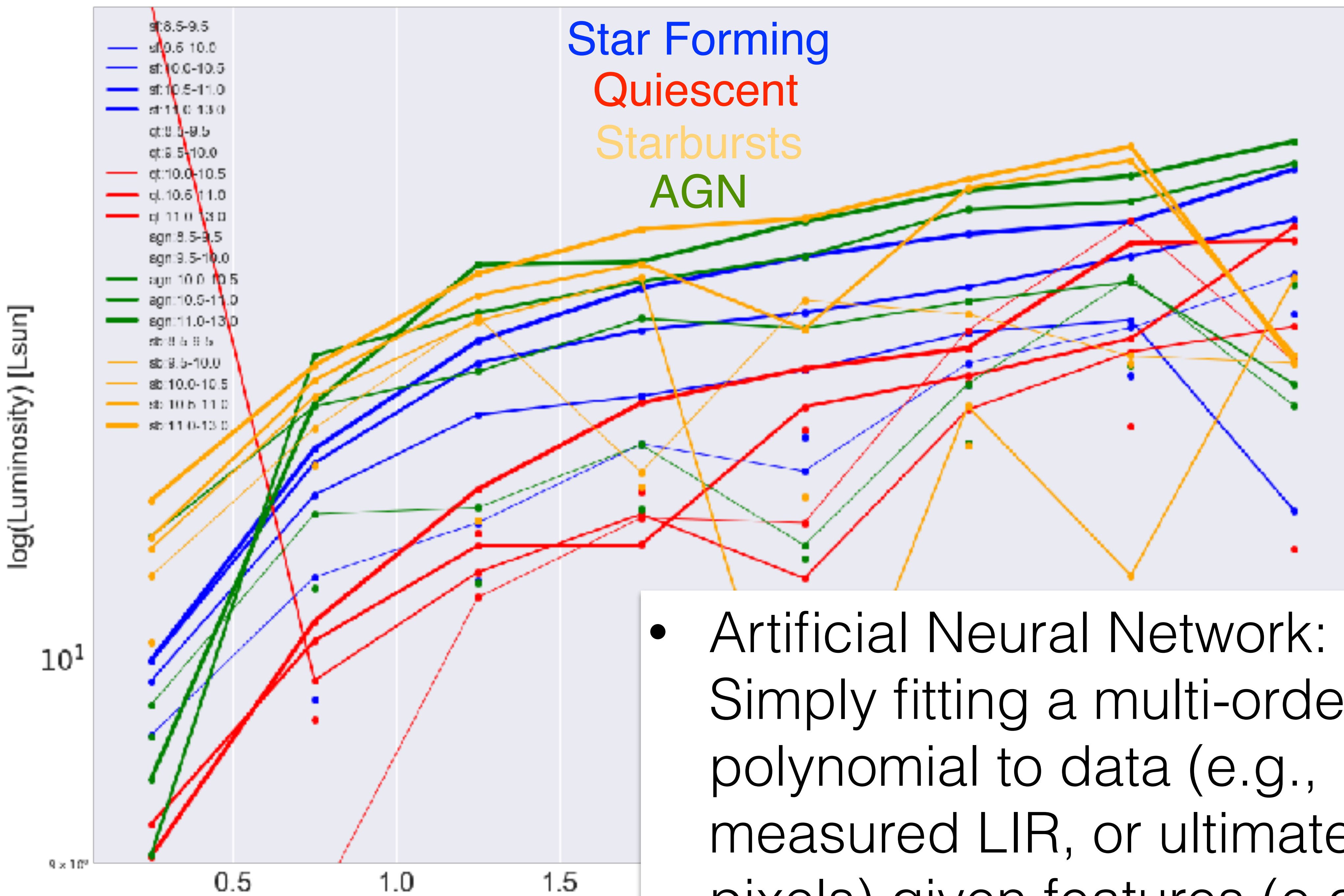


Sun, Moncelsi, Viero + (2016)
arXiv:1610.10095

Next Steps: Explore Galaxy Features with Artificial Neural Networks (ANN)

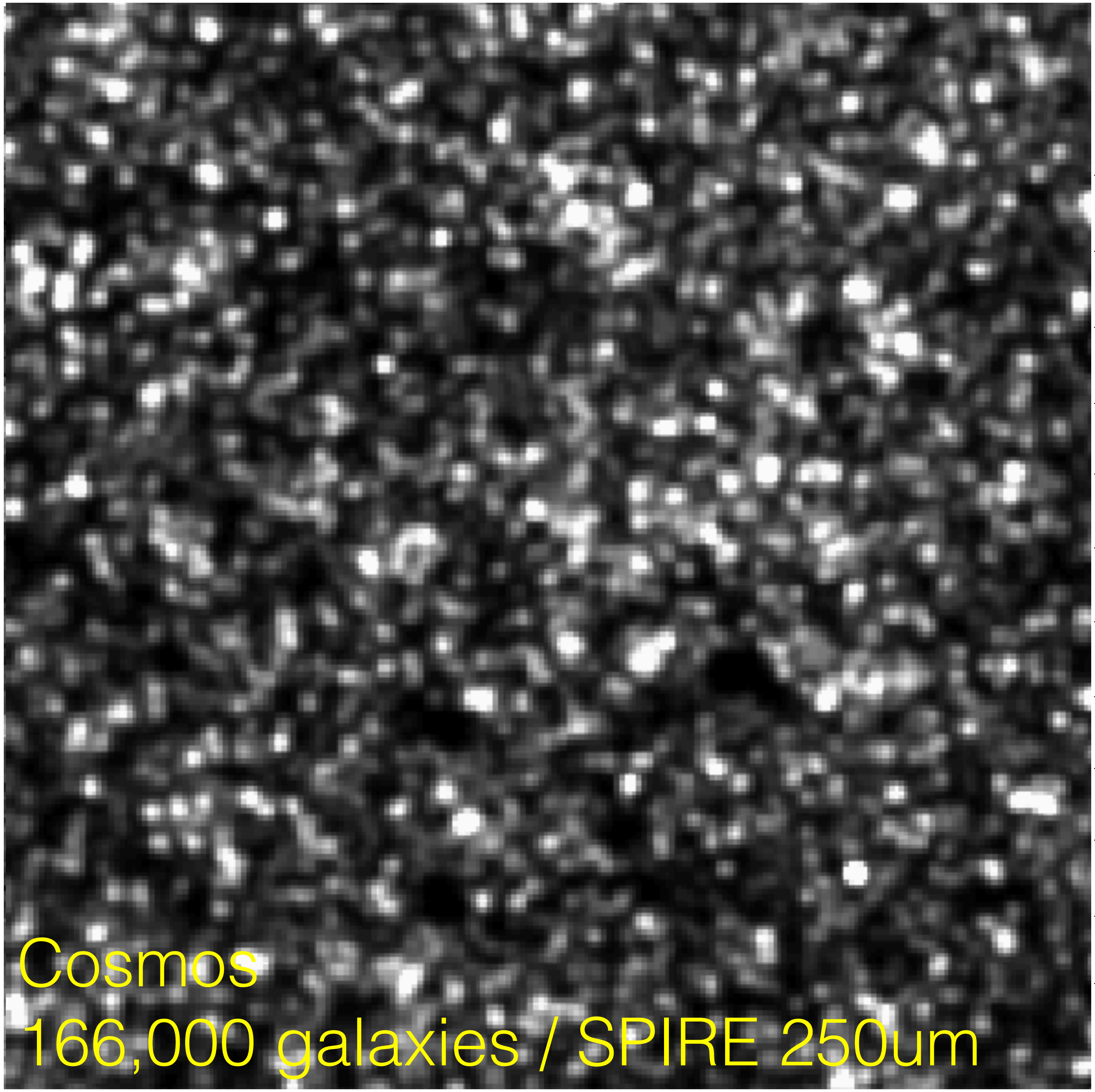
- Galaxies consist of more than just stellar mass and redshift, and are not only star-forming or quiescent, e.g.,
    - dusty/dust-free
    - AGN component
    - starburst
    - etc.
- Key is to identify "**features**" which correlate with Infrared Luminosity (LIR), and use them to "predict" LIR

Next Steps



- Artificial Neural Network: Simply fitting a multi-order polynomial to data (e.g., measured LIR, or ultimately map pixels) given features (e.g., z, stellar-mass, AGN diagnostics, other…)

SIMSTACK: Artificial Neural Network Results



ANN Flux	RA	DEC
41.4	149.853	2.608
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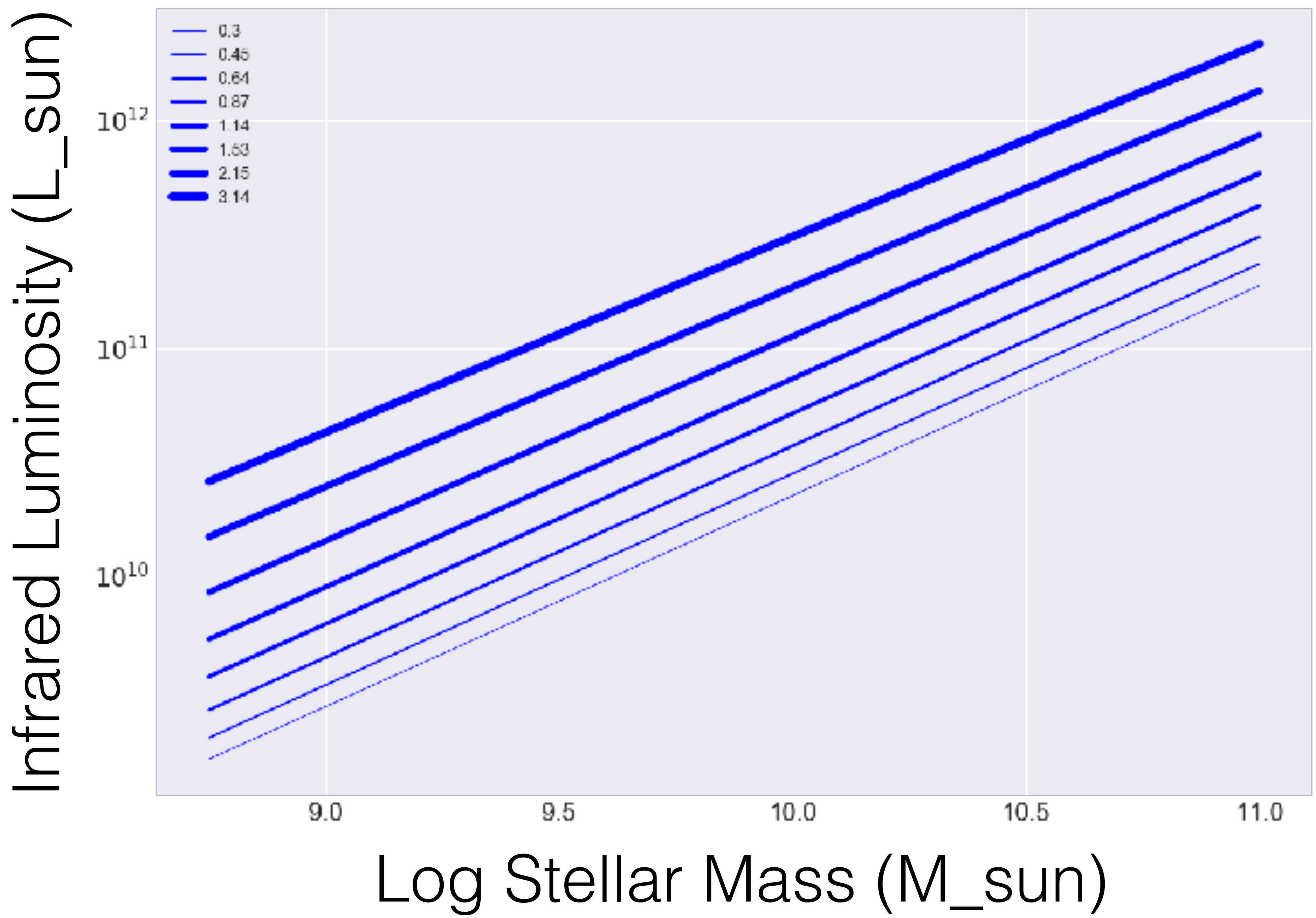
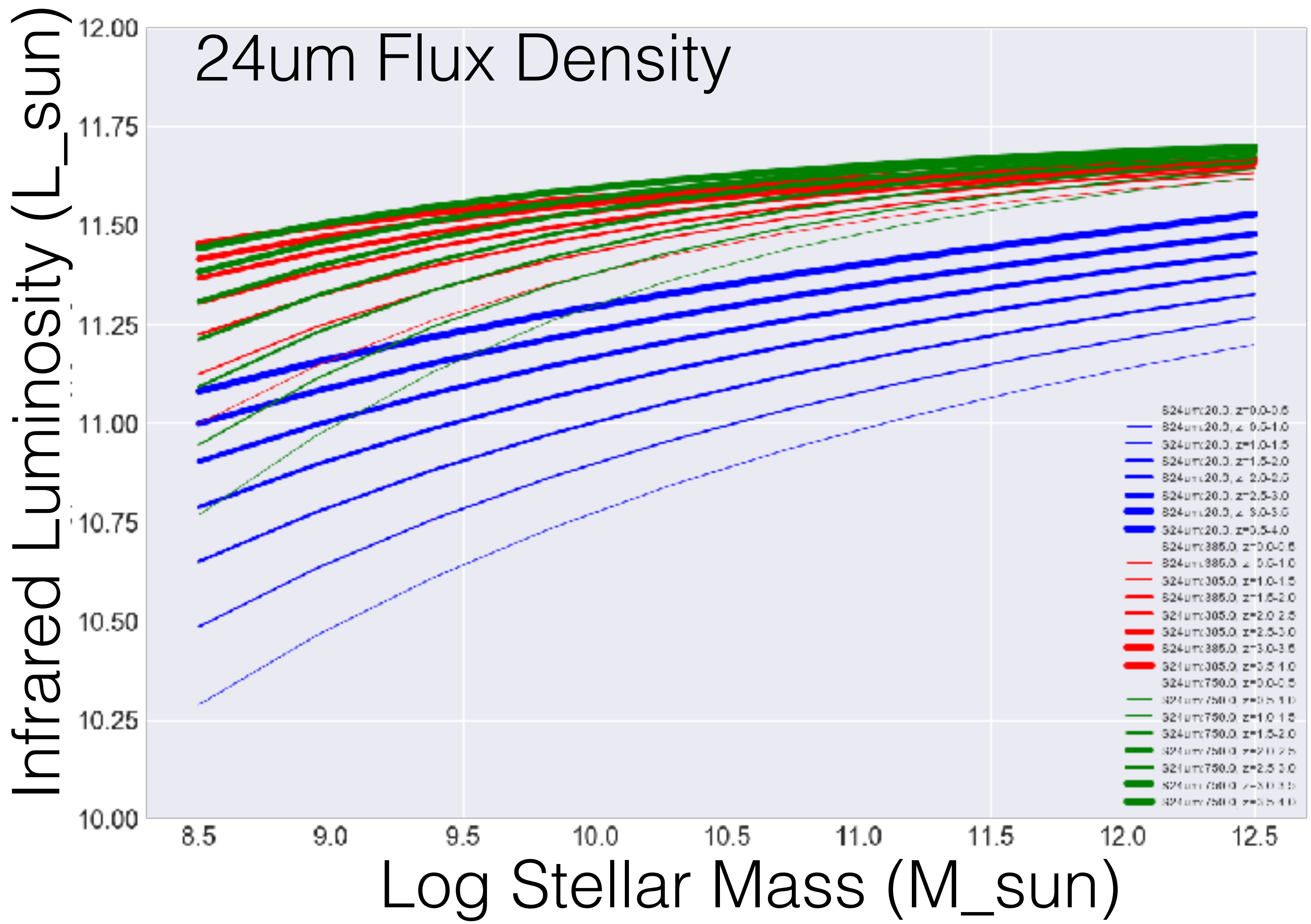
…	…	…

Explore Secondary Effects on Main Sequence

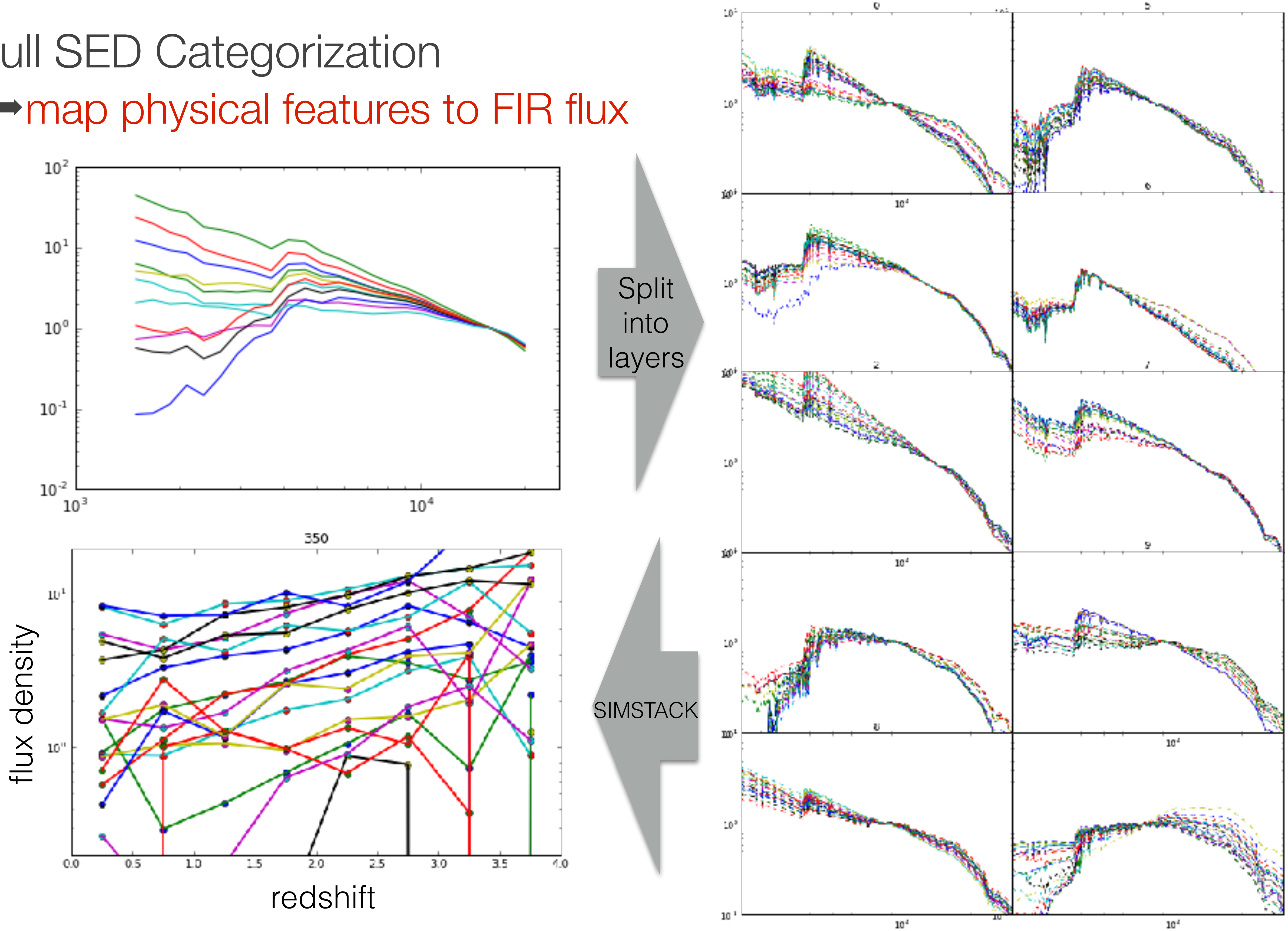


Explore Secondary Effects on Main Sequence



SIMSTACK: ANN to Deep Learning

- Full SED Categorization
  - ➡ map physical features to FIR flux



Summary

- Use all the data in the maps
- Ancillary data can be a powerful
- There are still challenges