Semi-Analytic Forecasts for Roman

# Lightcone Constructions and Simulated Observations for *Roman*


L. Y. Aaron Yung

*NASA Postdoctoral Fellow (Code 665)*



*special thanks to key collaborators:*

*James Rhoads (NASA Goddard)*

*Sangeeta Malhotra (NASA Goddard)*

*Jonathan Gardner (NASA Goddard)*

*rachel somerville (Flatiron/CCA)*

*Steve Finkelstein (UT Austin)*

*Micaela Bagley (UT Austin)*

*Roman Cosmic Dawn SIT*

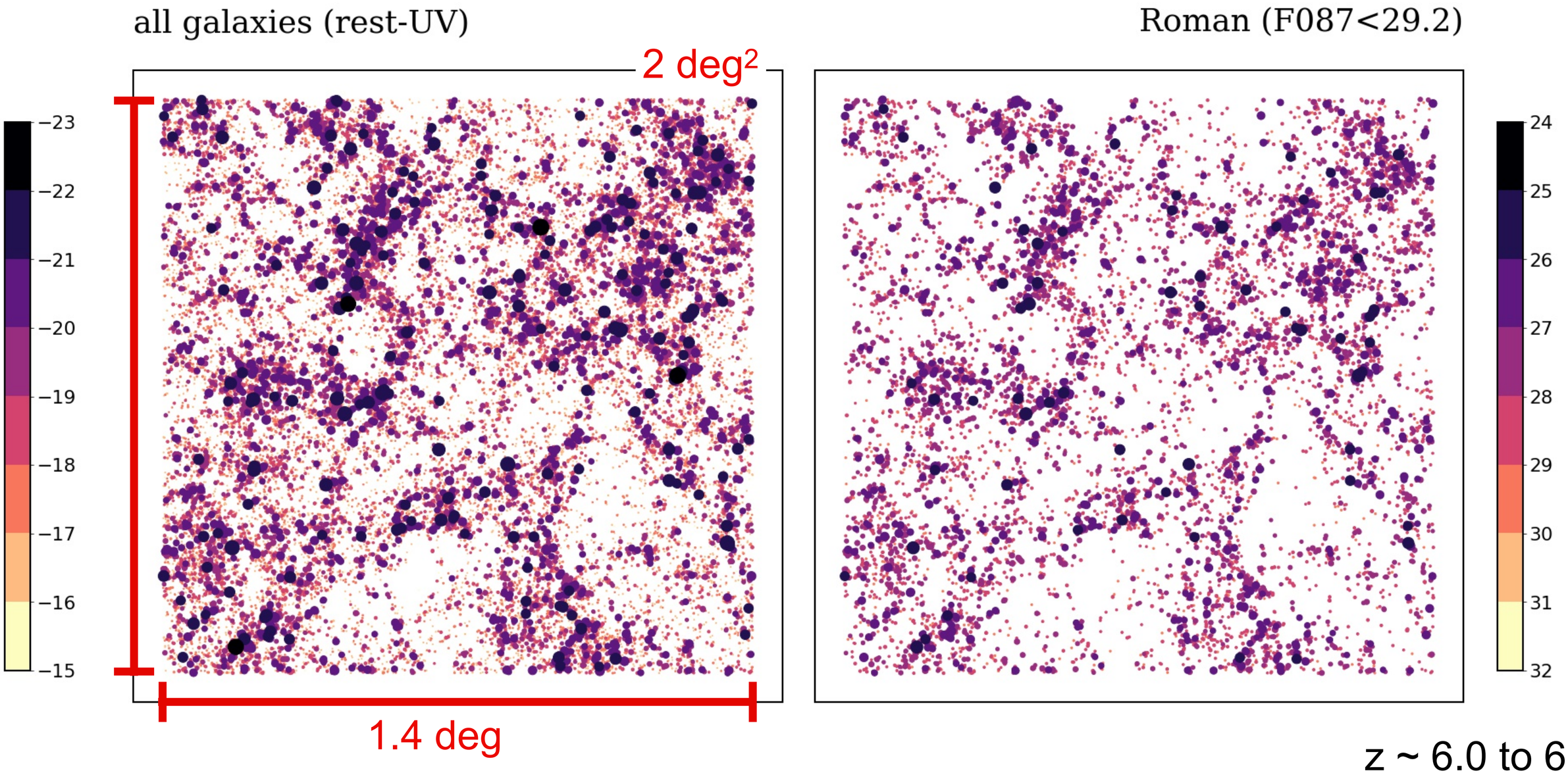


email: aaron.yung@nasa.gov

website: lyaaronyung.github.io


Nov 18, 2021

*Roman Science Team Community Briefing*



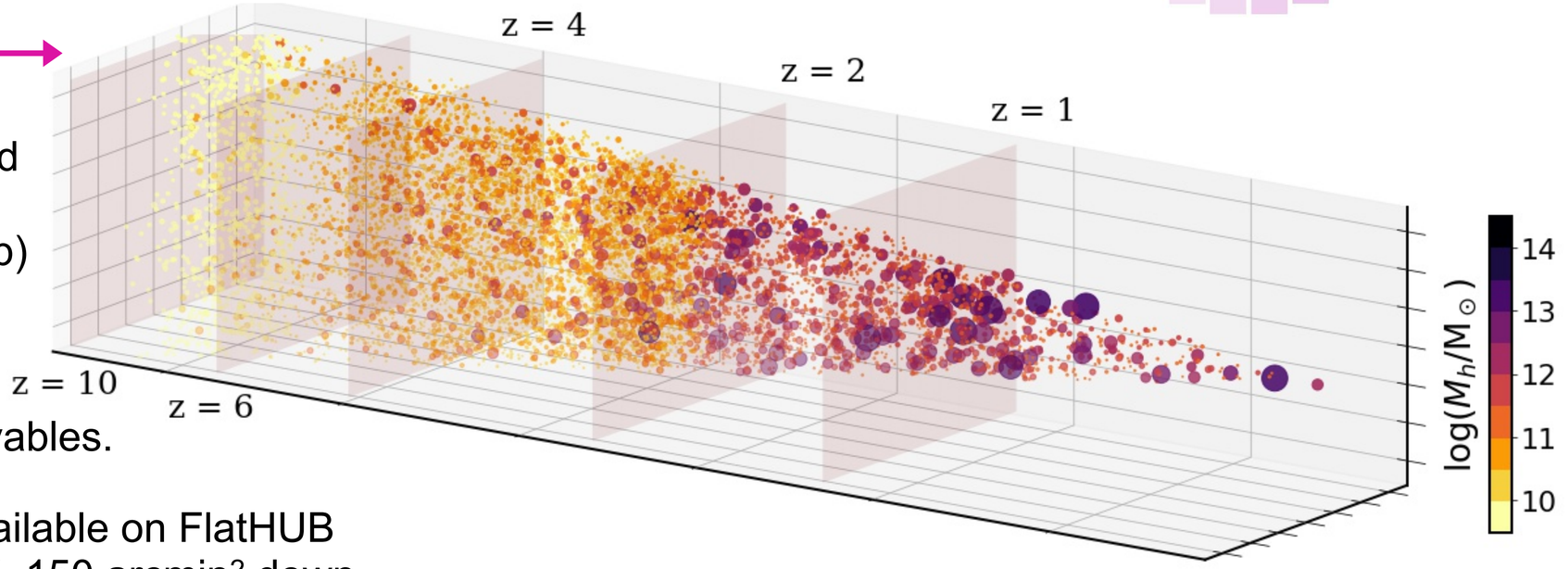

z ~ 6.0 to 6.1
(Yung et al., in prep b)

# *A brief overview on*
# the Construction of Mock Lightcones

Semi-Analytic Forecasts for JWST

Semi-Analytic Forecasts for Roman

- DM halos extracted from SMDPL (Klypin+2016) and arranged into a mock observing field using code from Behroozi+2019 (e.g. darkcone)
- Use the Santa Cruz SAM to populate the halos with galaxies predicted based on a physical model . (Somerville+1999, 2015; Yung+2019ab)
- Galaxies with SFH / metallicity predictions are forward modeled into rest-frame and observed-frame observables.
- CANDELS field (~700 arcmin$^2$) are available on FlatHUB today. We will release the DEEP field (~150 arcmin$^2$ down to $M_{UV}$ ~ -15) and Roman wide field (2 deg$^2$) in ~2 months.




Google for Early Data Access

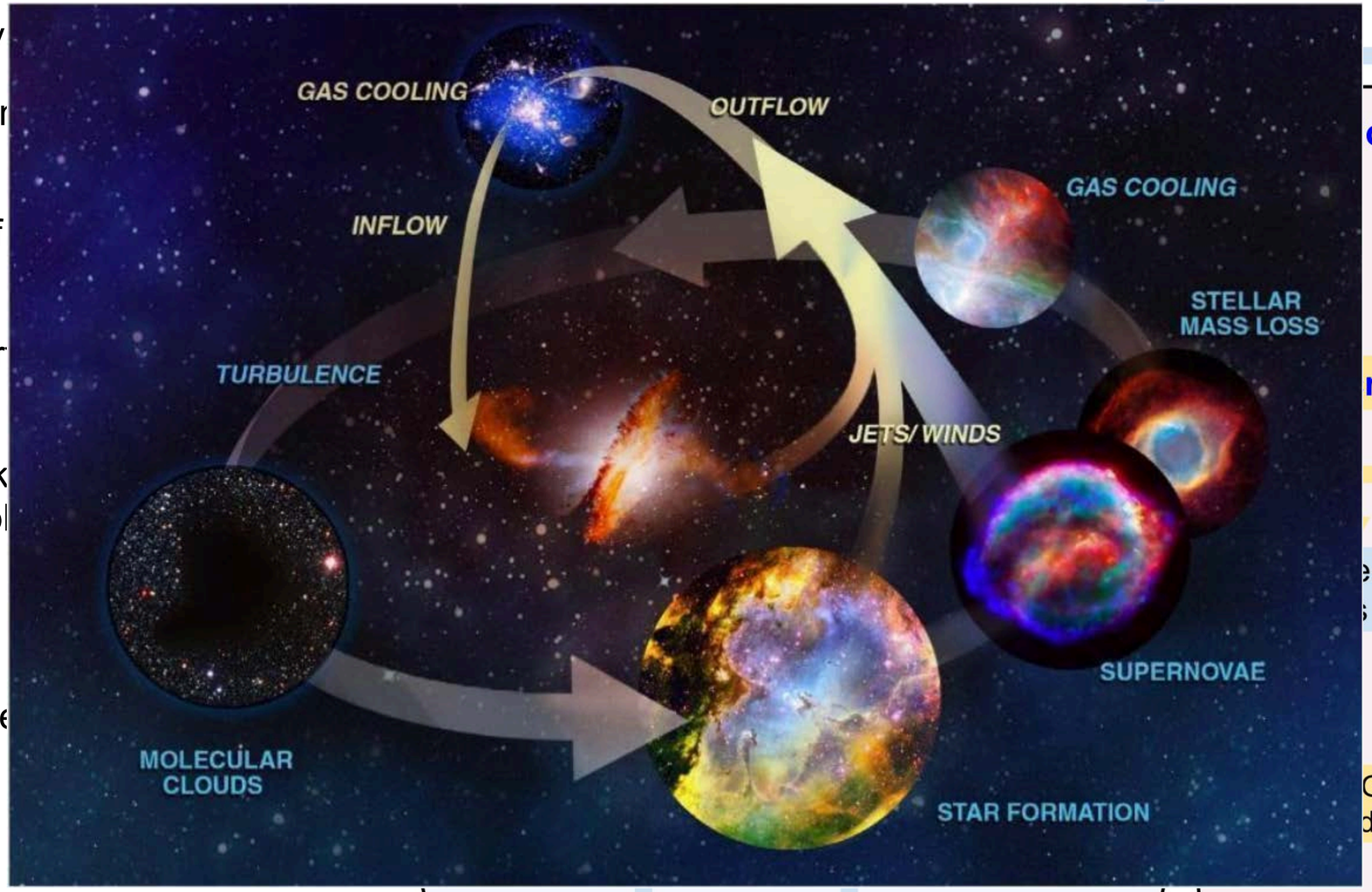
Flatiron Institute FlatHUB (SC-SAM)

Somerville et al. 2021
Yung et al. in prep a, b

# What's inside the Santa Cruz SAM?

Dark Matter Halo

- **Dark Matter Halo** - merger and assembly
- **Galaxy Merger** - may trigger starbursts ar change the properties of galaxies
- **Cooling of Gas** - hot gas need to cool off forming stars
- **Chemical Evolution** - "metal" is an impor also crucial to creating stars
- **Star Formation** - although stars only mak total galaxy mass, they emit most of the pl
- **Supernovae Feedback** - exploding stars eject gas!
- **Outflow and Reheating Gas** - gas can be and part of the expelled gas can fall back
- **And many others!!**




Somerville+1999b, 2008, 2012, 2015
Hirschmann+2012, 2017; Popping+2014

# What are we delivering?

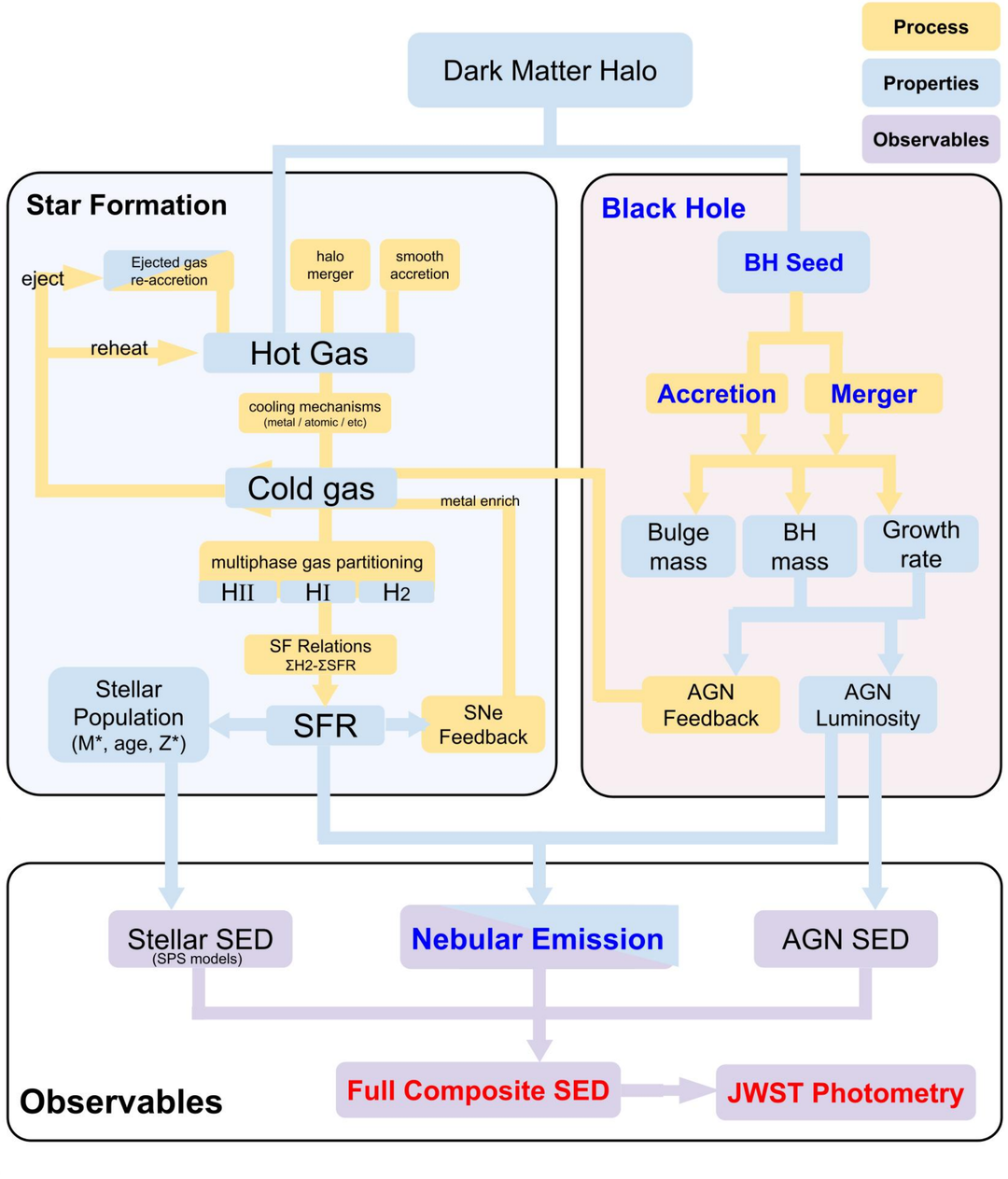
- **Note:**
  - free parameters are only calibrated once at z ~ 0
  - shown to well-reproduce the observed evolution at high z
- **Pros:**
  - extremely efficient
  - wide dynamic range
  - have direct control over the physics going into the mode
- **Cons:**
  - objects are not spatially resolve
  - no internal geometry
  - no environmental effects

## Physical Properties

- **star formation rate**
- **stellar mass**
- cold gas mass
- disc size
- metallicity
- **LyC production**
- etc.

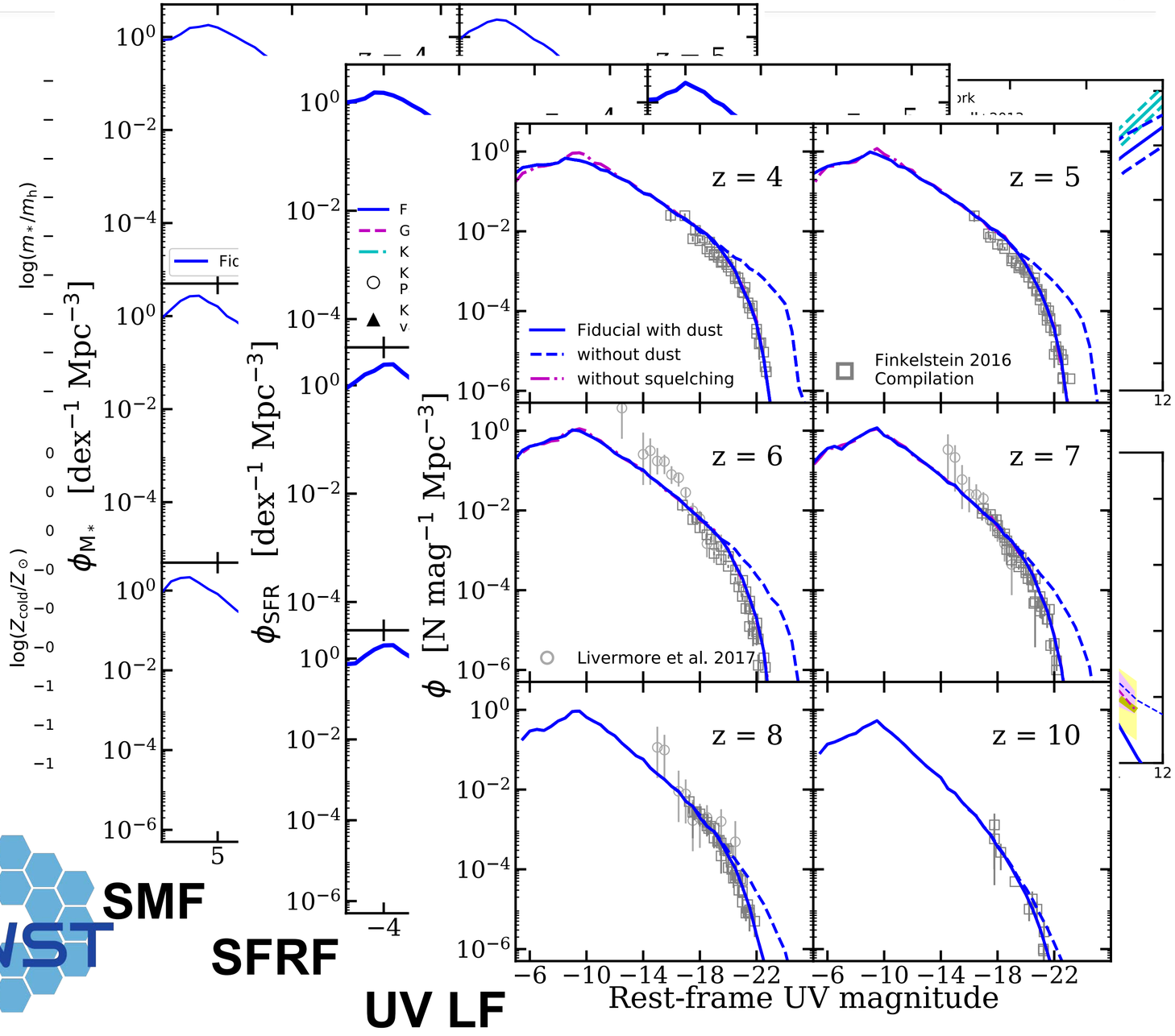
## Observables

- **synthetic SED (AGN + stellar)**
- UV luminosity
- observers' frame **photometries**
- emission lines
- etc.



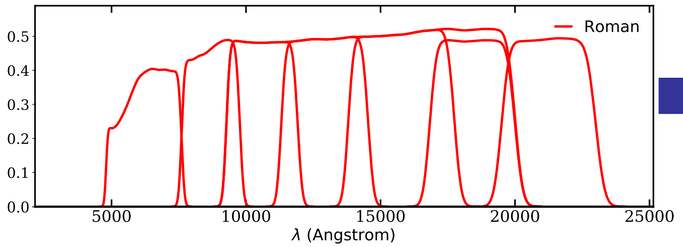
# A promising starting point

- EPS merger trees enable efficient sampling of galaxies forming in halos across a wide mass range
- Free parameters in the model are only calibrated to observations at z ~ 0
- The Santa Cruz semi-analytic model (SC SAM) has been shown to reproduce observations at low redshifts (e.g. z < 6) in Somerville+2015, 2021, etc
- The physical model was tested extensively against existing high-z observations (Yung et al. 2019ab, 2020ab)
- AGN prediction capabilities added in Yung et al. 2021

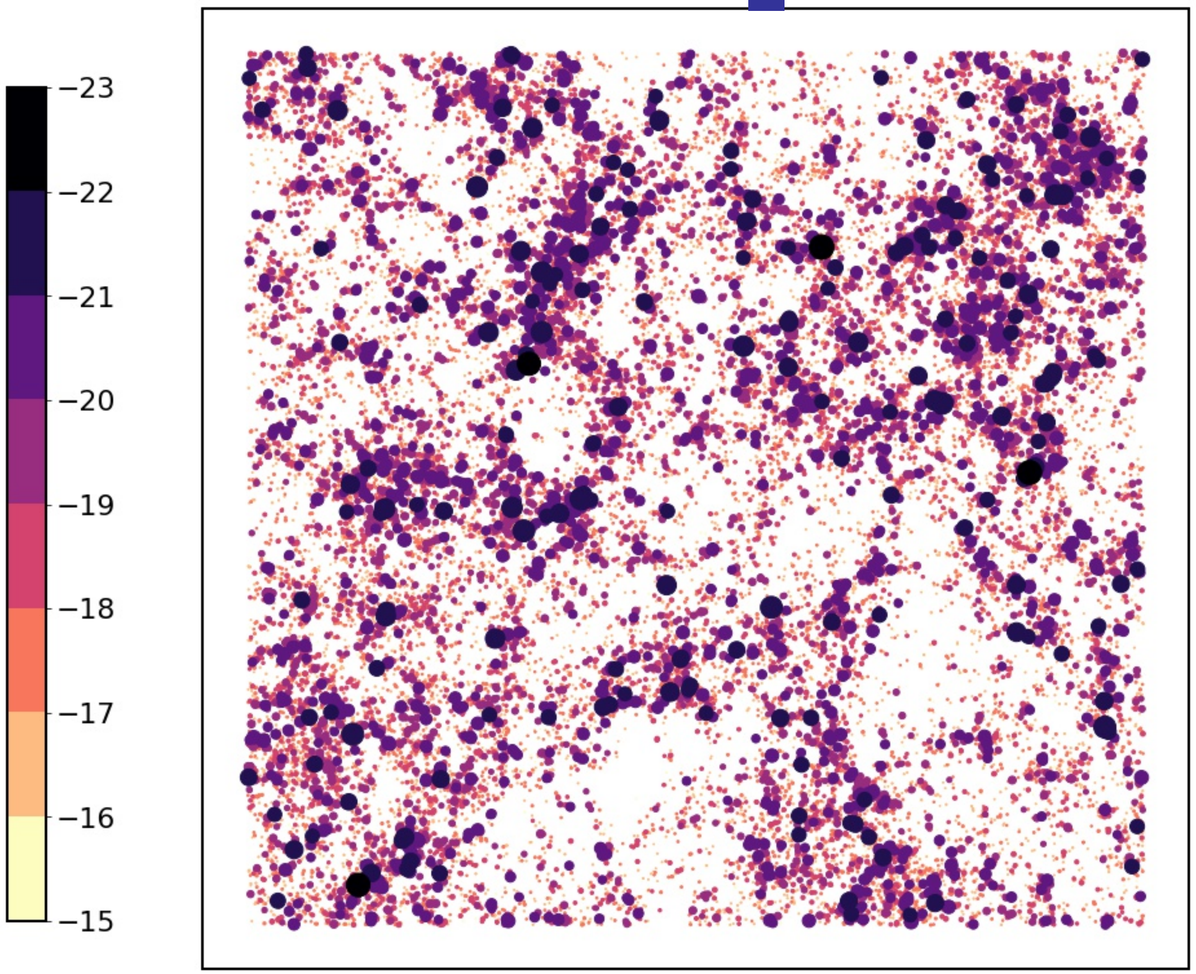



Semi-Analytic Forecasts for JWST

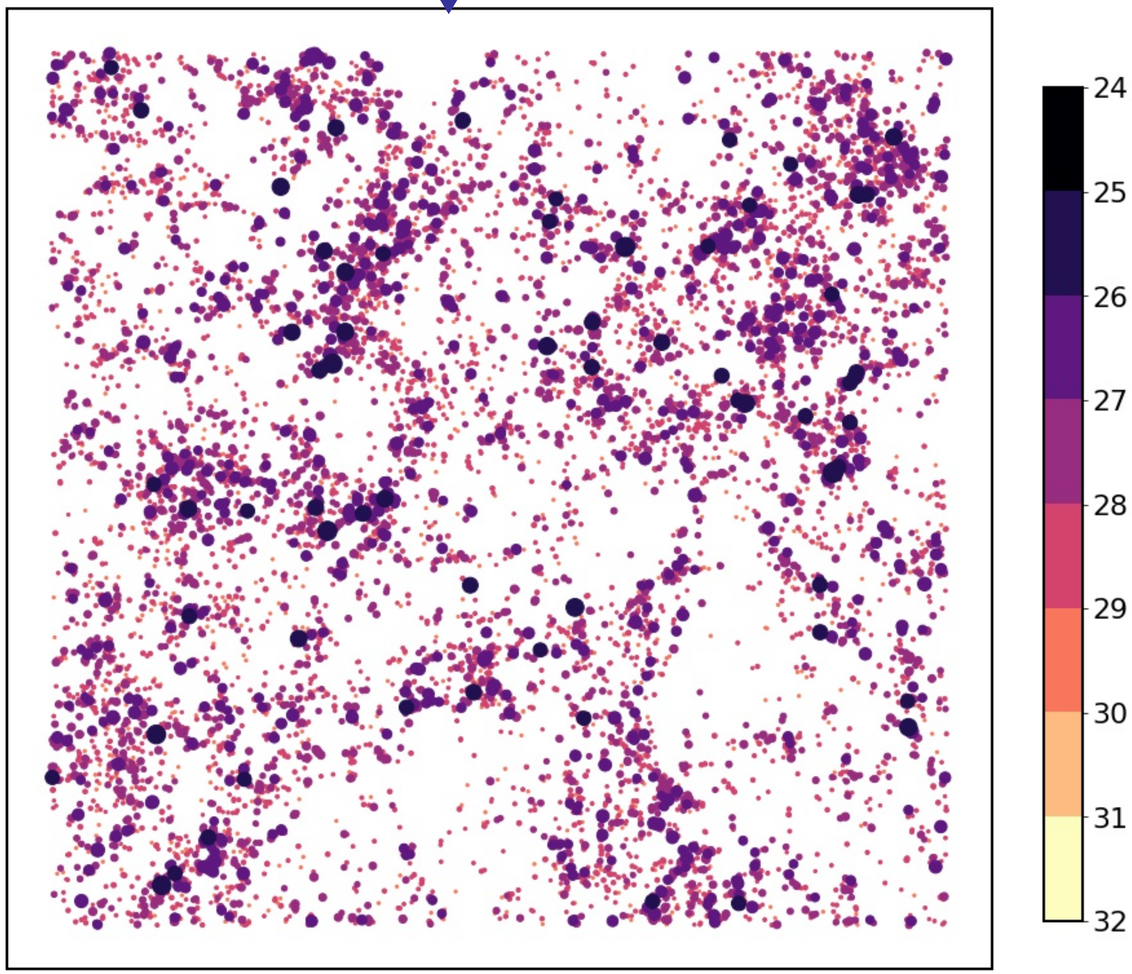
L.Y. Aaron Yung

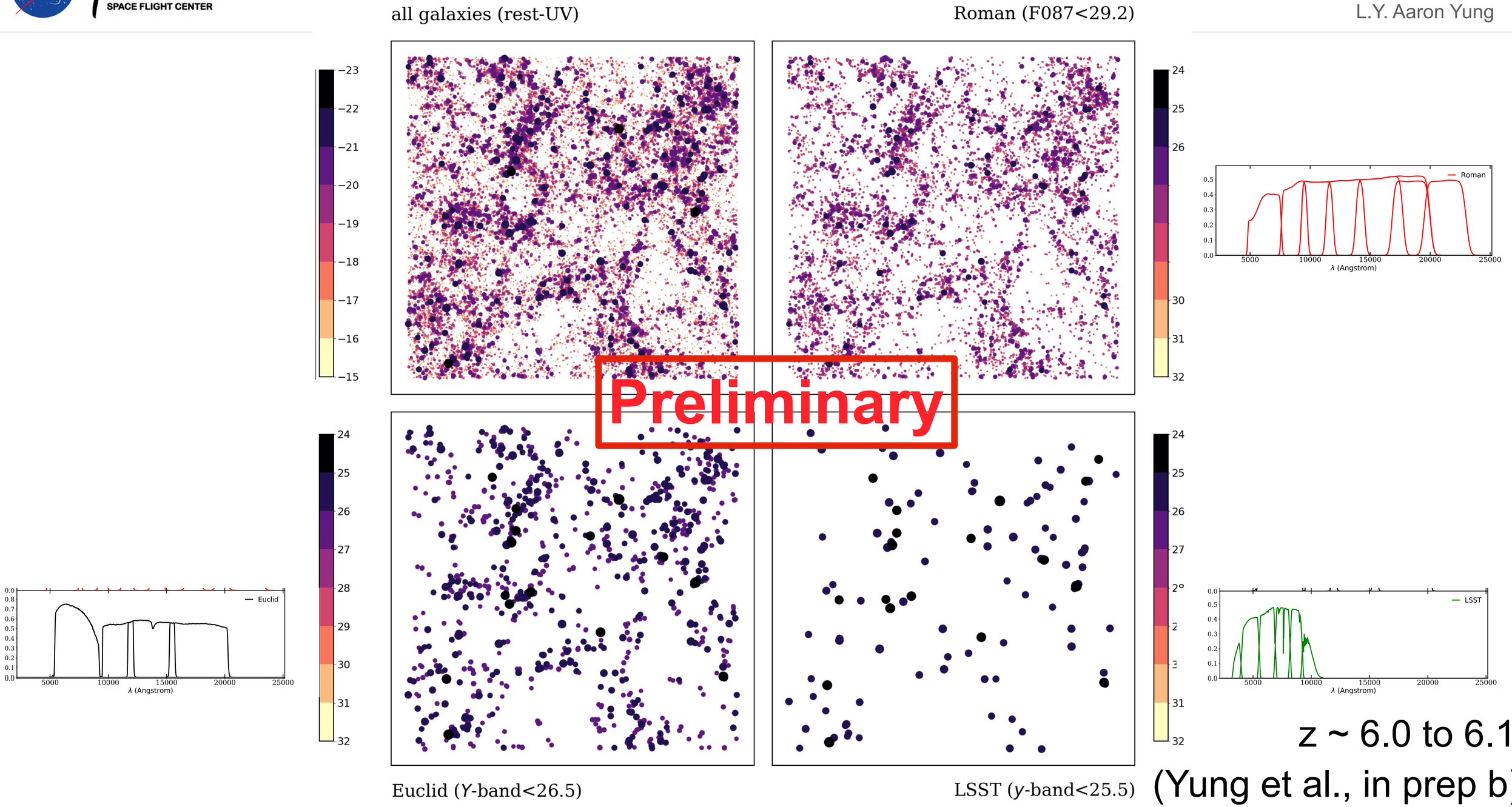



all galaxies (rest-UV)




Roman (F087<29.2)





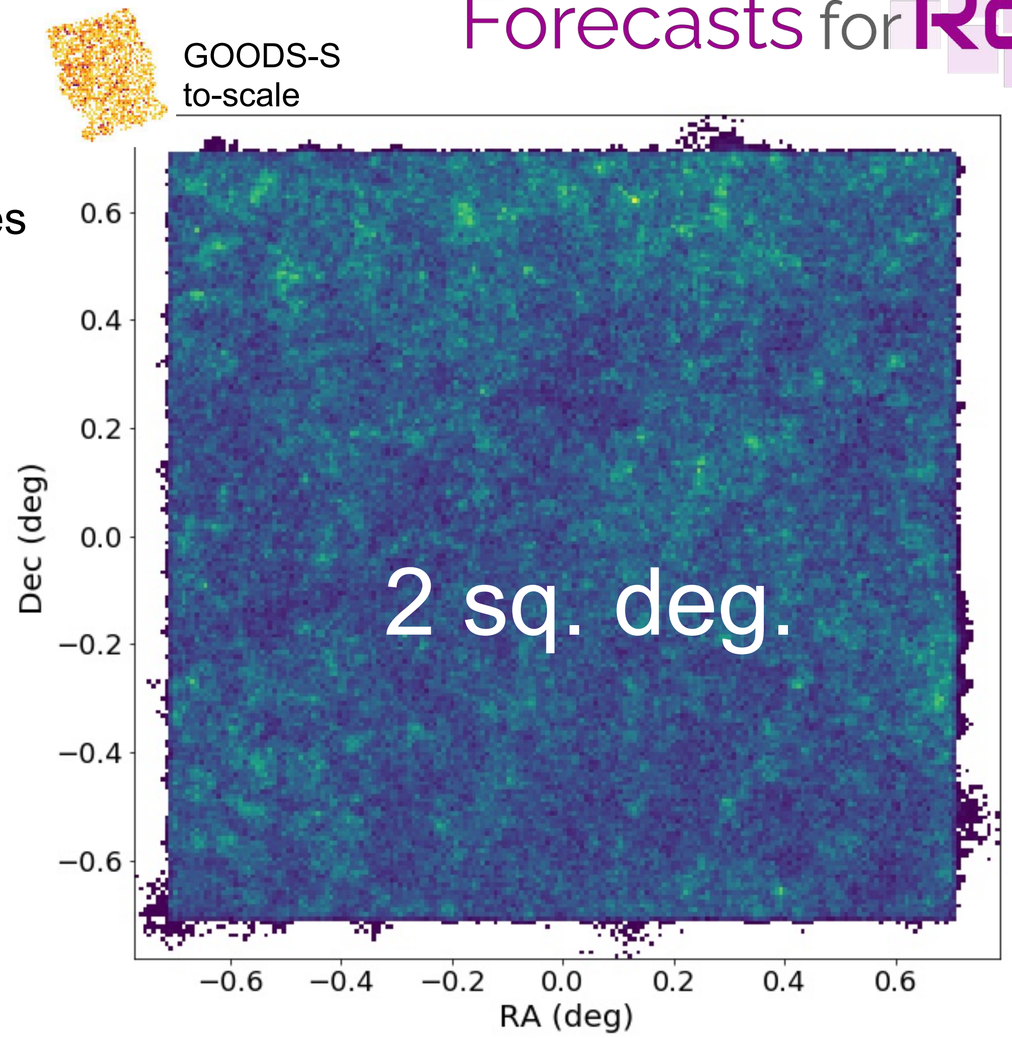

z ~ 6.0 to 6.1

(Yung et al., in prep b)

# Summary

Semi-Analytic Forecasts for Roman

- We have developed a modeling pipeline that scales up a well-tested galaxy formation model and mock catalogues to make predictions for a 2 sq. deg. field
- These results have already featured in several studies and shown their superior capabilities in studying galaxy clustering (e.g. Kakos+ in prep)
- check out data release portal @Flathub for mock catalogues and for upcoming data release http://flathub.flatironinstitute.org/group/candels




Lightcones coming Early 2022
Stay tuned for **Paper VI** & **Paper R**

Meanwhile, check out
**Paper I** [arXiv:1803.09761]
**Paper II** [arXiv:1901.05964]
**Paper III** [arXiv:1910.11345]
**Paper IV** [arXiv:2001.08751]
**Paper V** [arXiv:2109.13241]

Email: **aaron.yung@nasa.gov**