Semi-Analytic Forecasts for Roman

Lightcone Constructions and Simulated Observations for Roman

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special thanks to key collaborators:

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Roman Cosmic Dawn SIT
all galaxies (rest-UV)  2 deg²  Roman (F087<29.2)

1.4 deg

z ~ 6.0 to 6.1

(Yung et al., in prep b)
A brief overview on the Construction of Mock Lightcones

- 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 $M_{UV} \sim -15$) and Roman wide field (2 deg$^2$) in ~2 months.
What’s inside the Santa Cruz SAM?

- **Dark Matter Halo** - merger and assembly history (merger trees)
- **Galaxy Merger** - may trigger starbursts and could significantly change the properties of galaxies
- **Cooling of Gas** - hot gas need to cool off before forming stars
- **Chemical Evolution** - “metal” is an important coolant, also crucial to creating stars
- **Star Formation** - although stars only make up about 1% of the total galaxy mass, they emit most of the photons we observe
- **Supernovae Feedback** - exploding stars can heat and eject gas!
- **Outflow and Reheating Gas** - gas can be heated and part of the expelled gas can fall back into the galaxy
- **And many others!!

Hirschmann+2012, 2017; Popping+2014
What are we delivering?

• Note:
  - free parameters are only calibrated once at $z \sim 0$
  - 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.

Pros:
- extremely efficient
- wide dynamic range
- have direct control over the physics going into the mode
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 $z \sim 0$
- 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
all galaxies (rest-UV)  

Roman (F087<29.2)
Preliminary

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2 sq. deg. Lightcone Constructions

all galaxies (rest-UV)  Roman (F087<29.2)

Euclid (Y-band<26.5)  LSST (y-band<25.5)

z ~ 6.0 to 6.1

(Yung et al., in prep b)
Summary

- 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 V [arXiv:2109.13241]