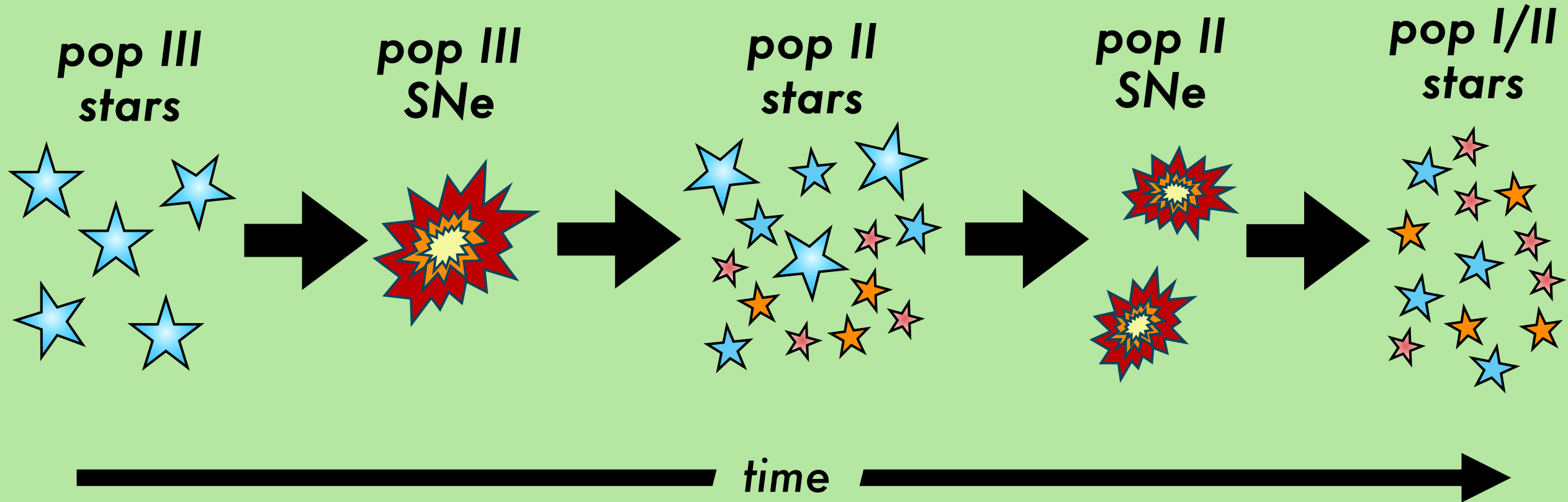


establishing a census of star formation across cosmic time with roman

sahil hegde

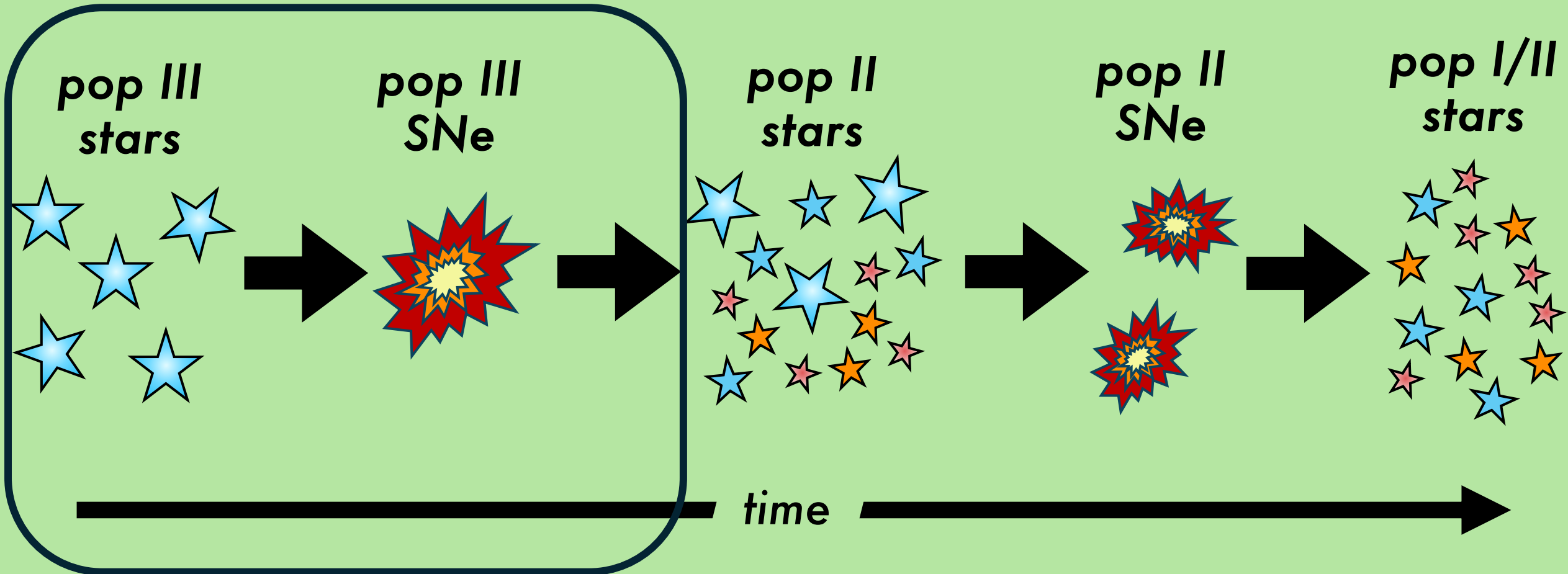
ucla / 07.15.26

a reductive timeline of the universe



part I

we don't have any constraints on the earliest phases of star formation

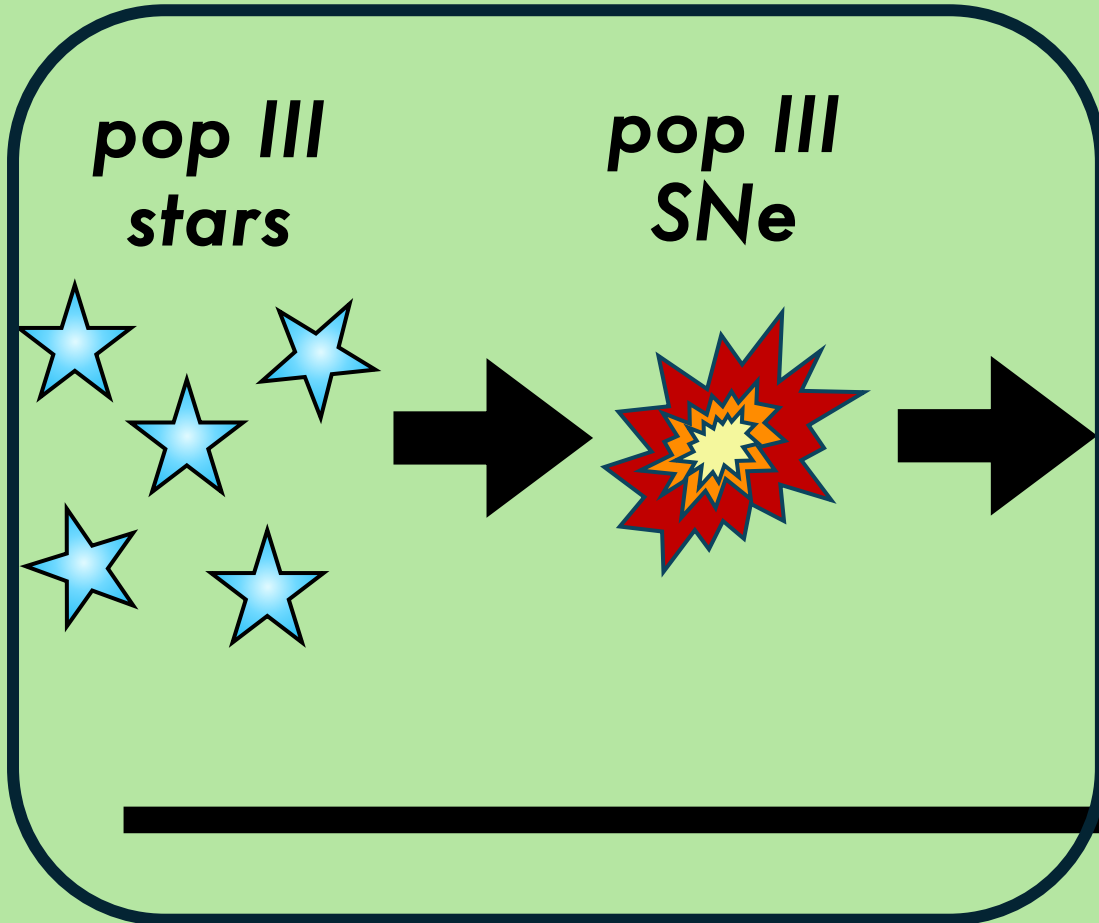


hegde & furlanetto (2023, 2025)

sahil hegde / [hegdesahil.github.io](https://github.com/hegdesahil) / sahil@astro.ucla.edu

part I

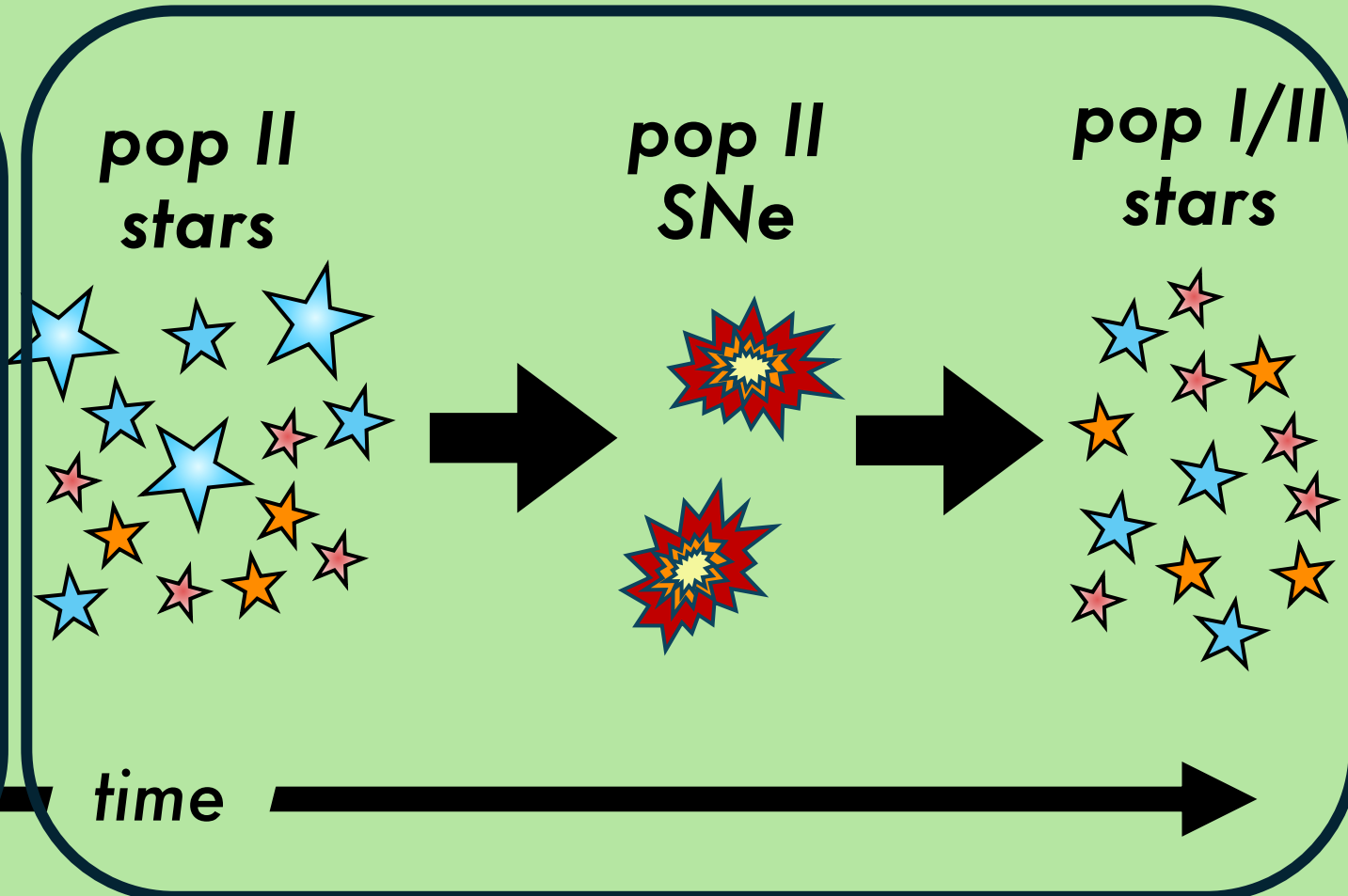
we don't have any constraints on the earliest phases of star formation



hegde & furlanetto (2023, 2025)

part II

there are longstanding uncertainties in our understanding of galaxies down to the local universe



hegde, furlanetto & naoz (2026)

part I

constraining population III star formation with high-z transients

hegde & furlanetto (2023, 2025)

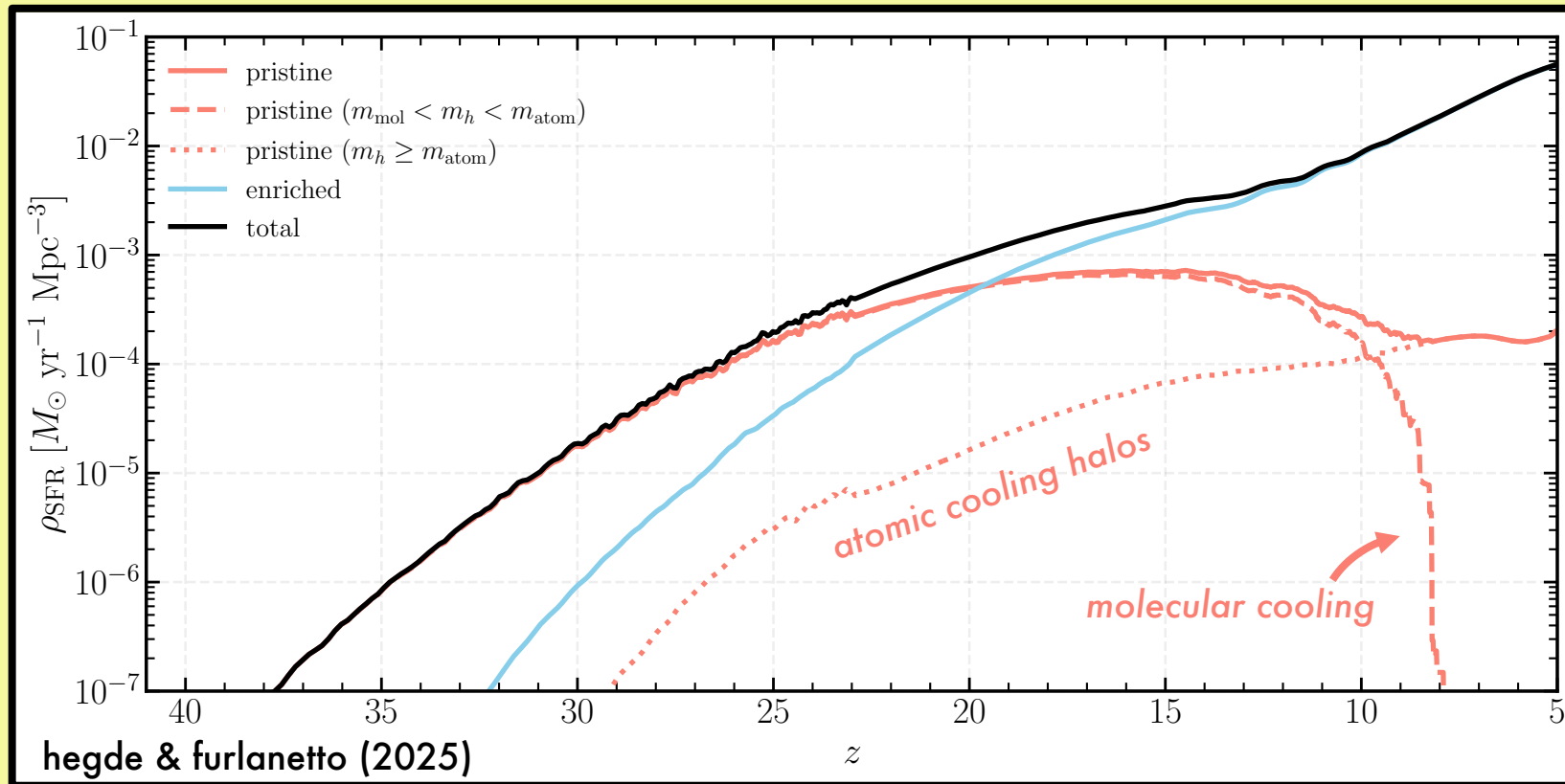
can we build an *efficient* model for early galaxies that also self-consistently includes pop III stars?



hegde & furlanetto (2025)

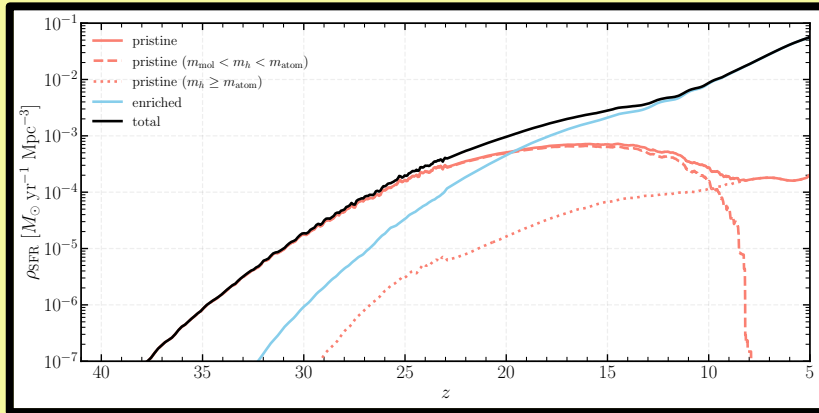
an **A**nalytic **B**athtub for **C**osmic **D**awn

pop III star formation persists down to the reionization era



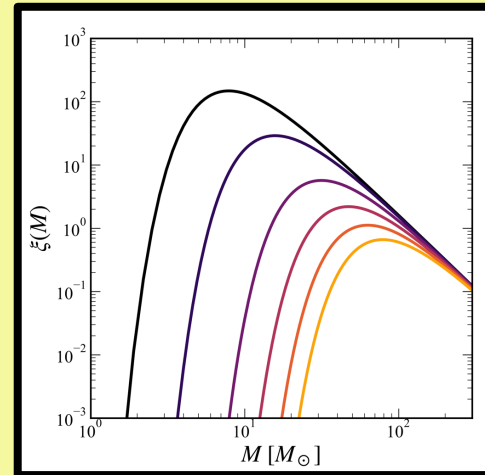
and pop III stars could produce pair–instability SNe

SFRD

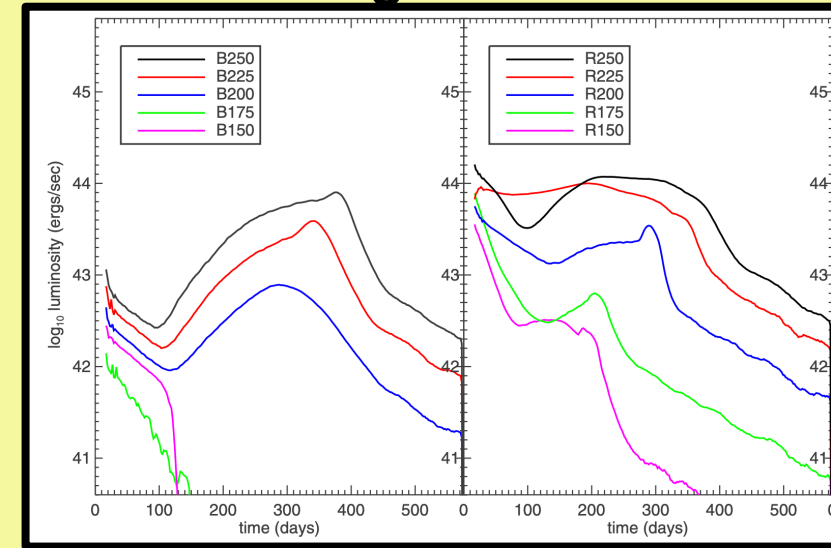


hegde & furlanetto (2025)

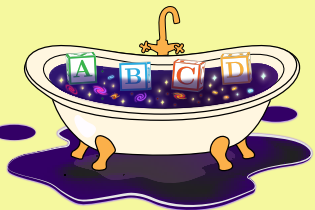
pop III IMF



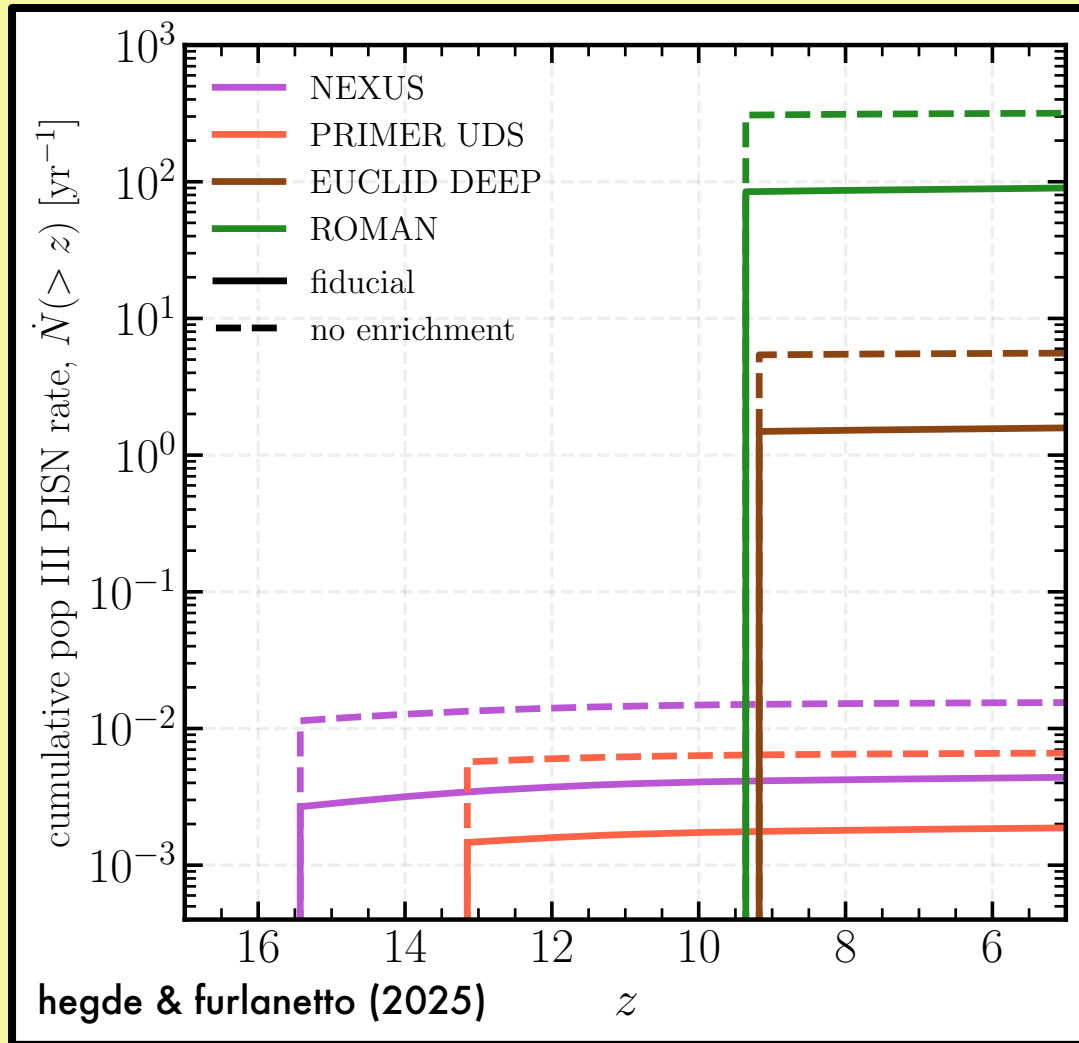
SN light curve



kasen+2011

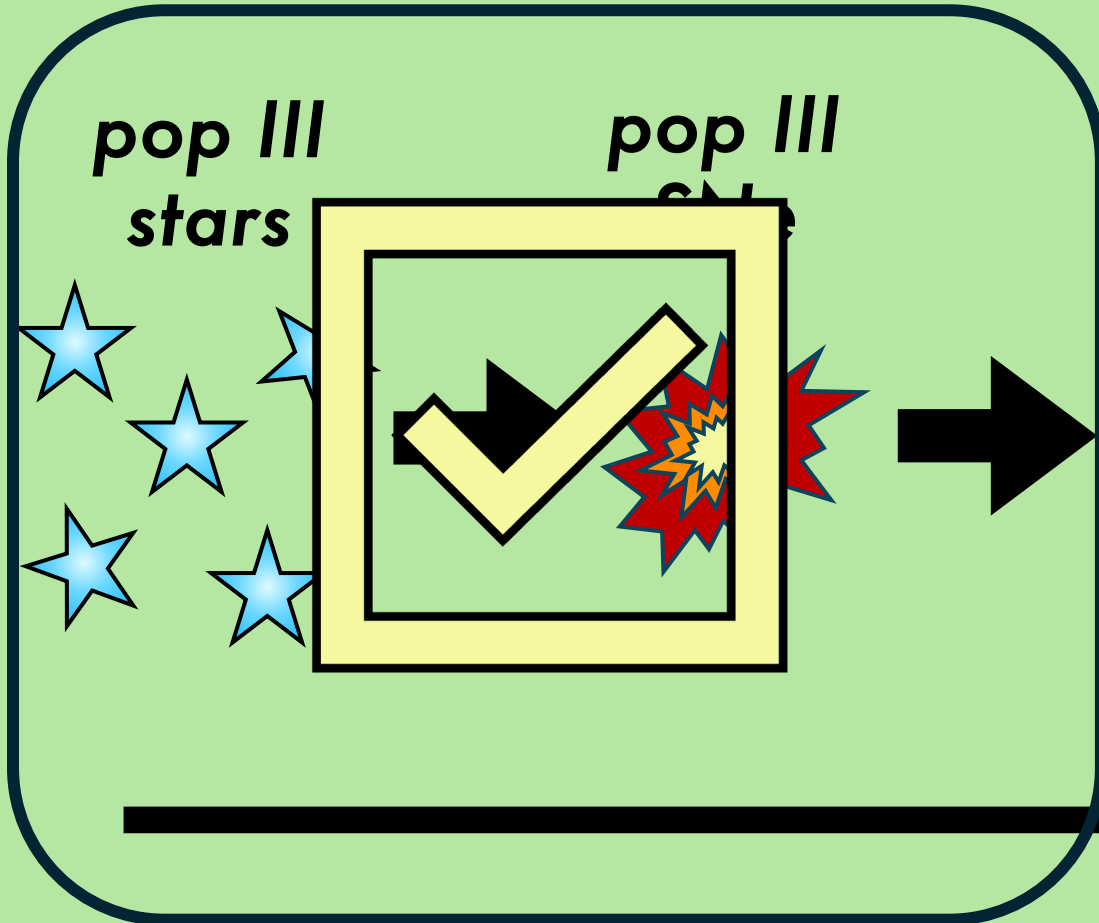


roman is uniquely suited to constrain the pop III IMF with SN rates over time



part I

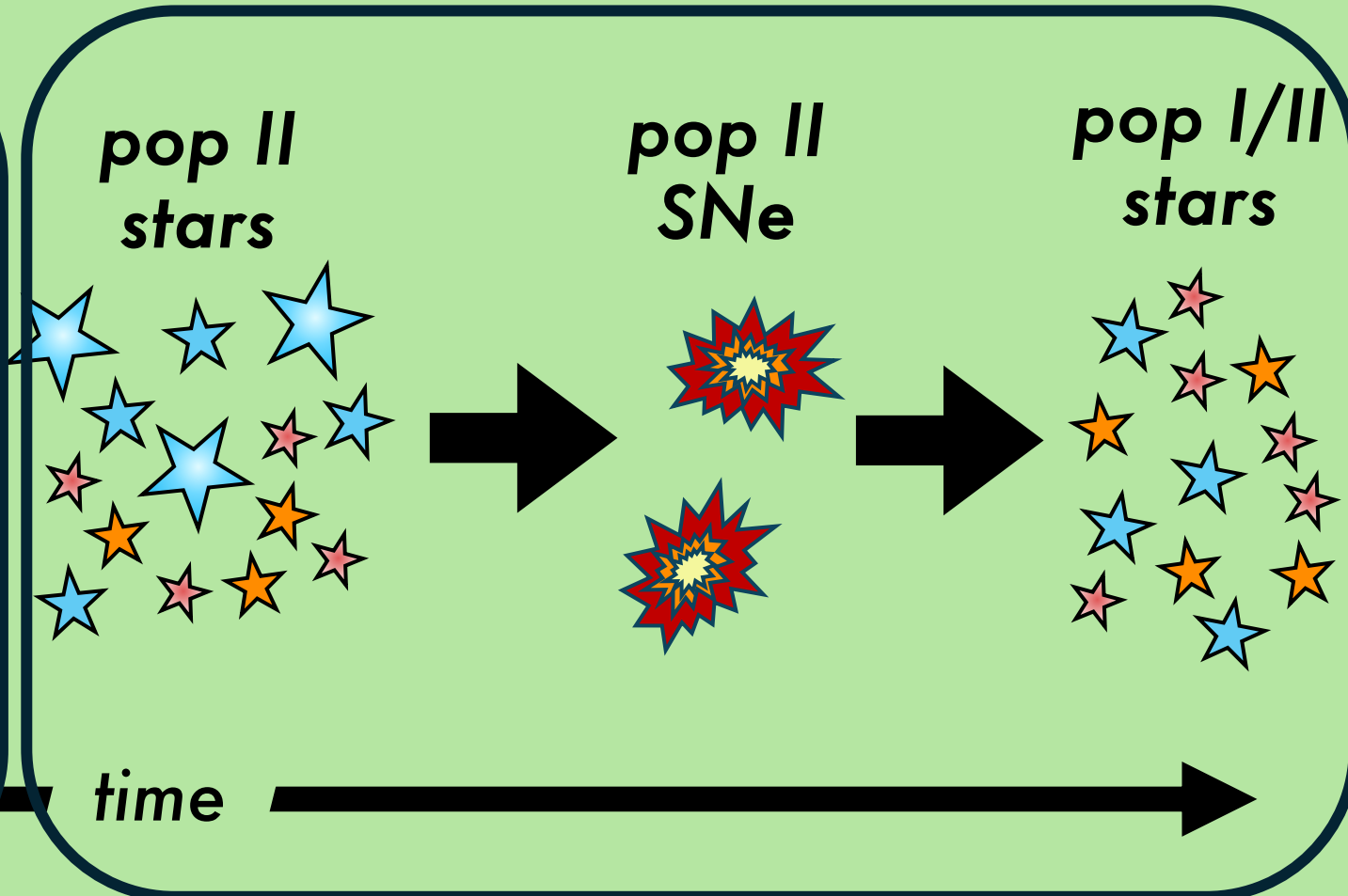
we don't have any constraints on the earliest phases of star formation



hegde & furlanetto (2023, 2025)

part II

there are longstanding uncertainties in our understanding of galaxies down to the local universe



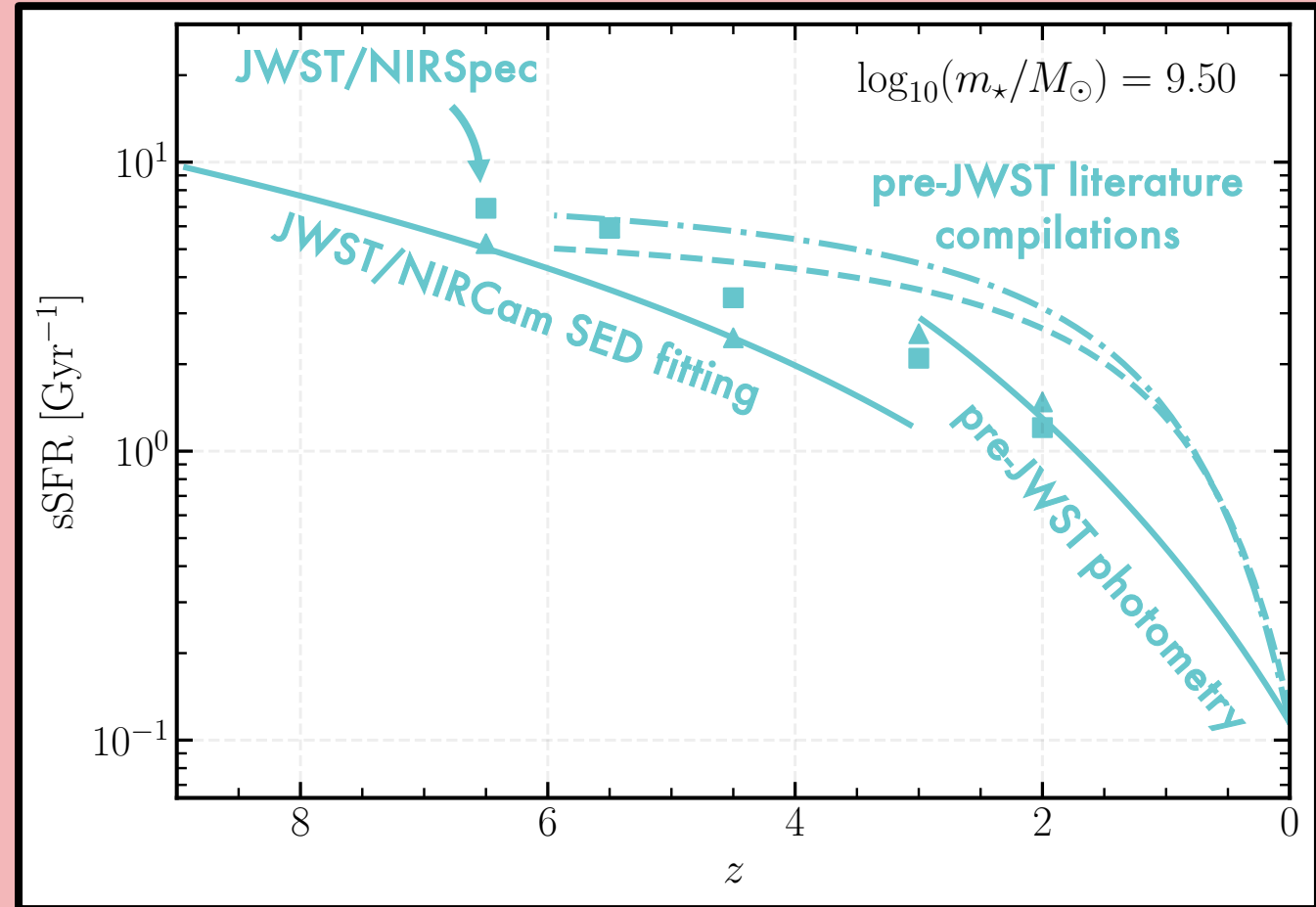
hegde, furlanetto & naoz (2026)

part II

inferring the star-forming main sequence with wide-field surveys

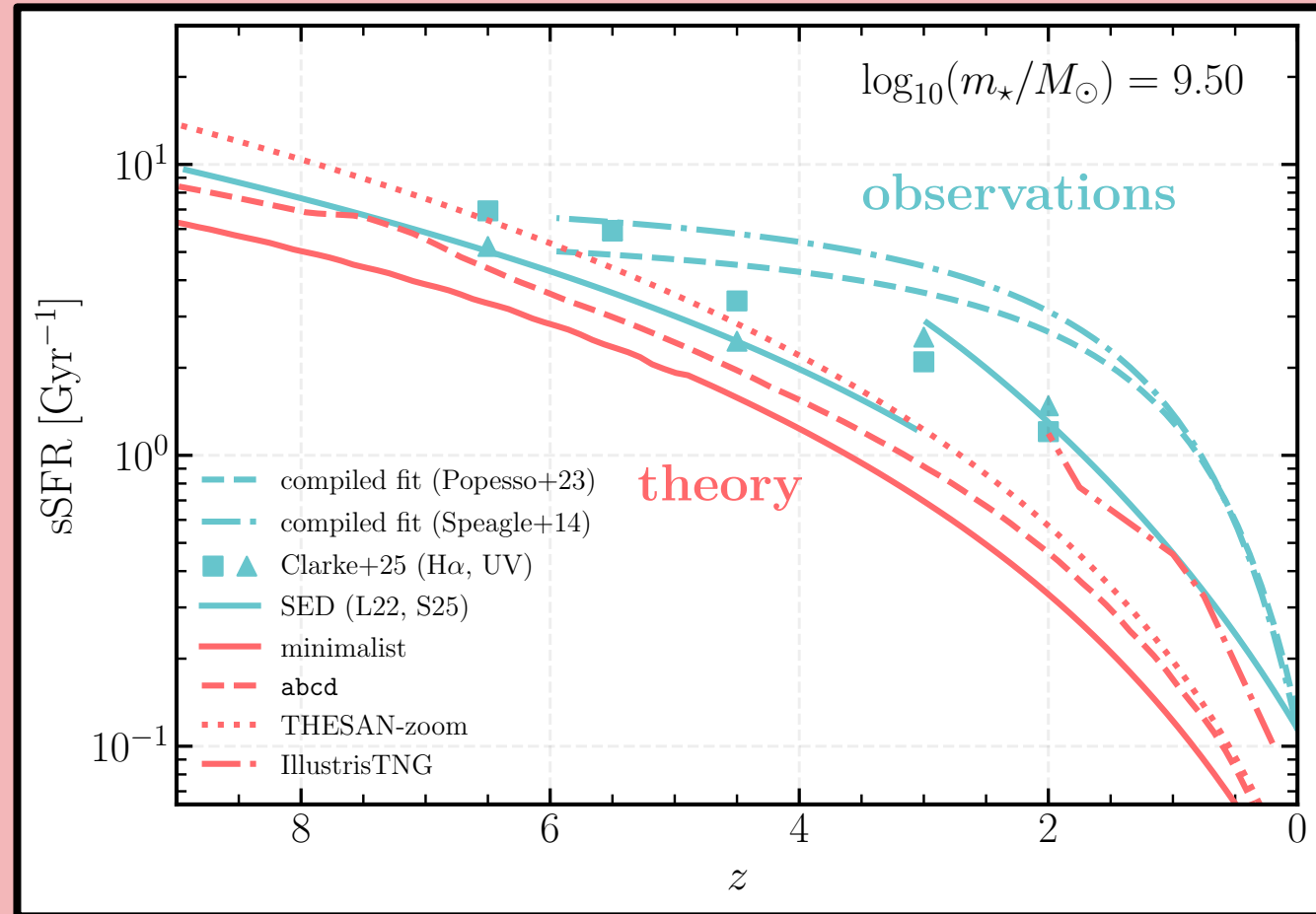
hegde, furlanetto & naoz (2026)

observations do not agree on the evolution, shape, and normalization of the star-forming main sequence



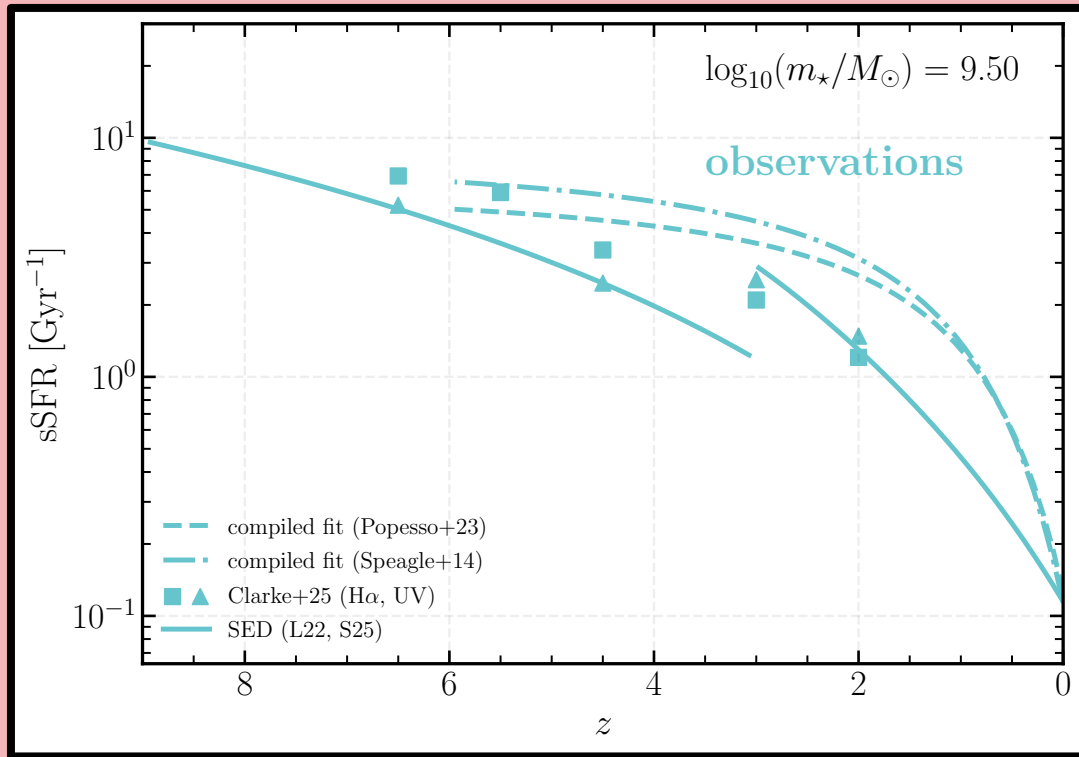
hegde, furlanetto & naoz (2026)

and theoretical
models have
struggled to
reproduce
observed SFRs

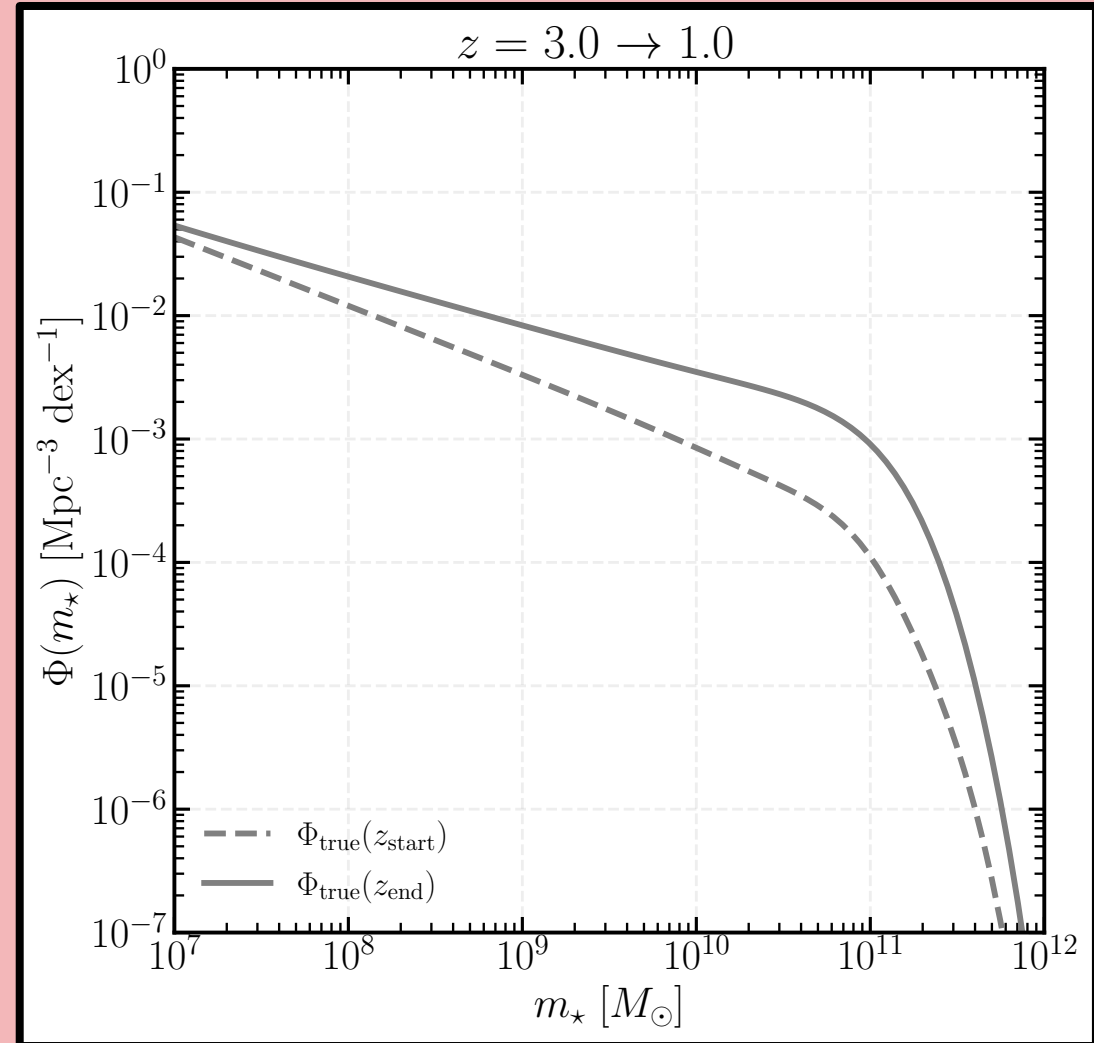
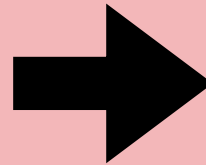


hegde, furlanetto & naoz (2026)

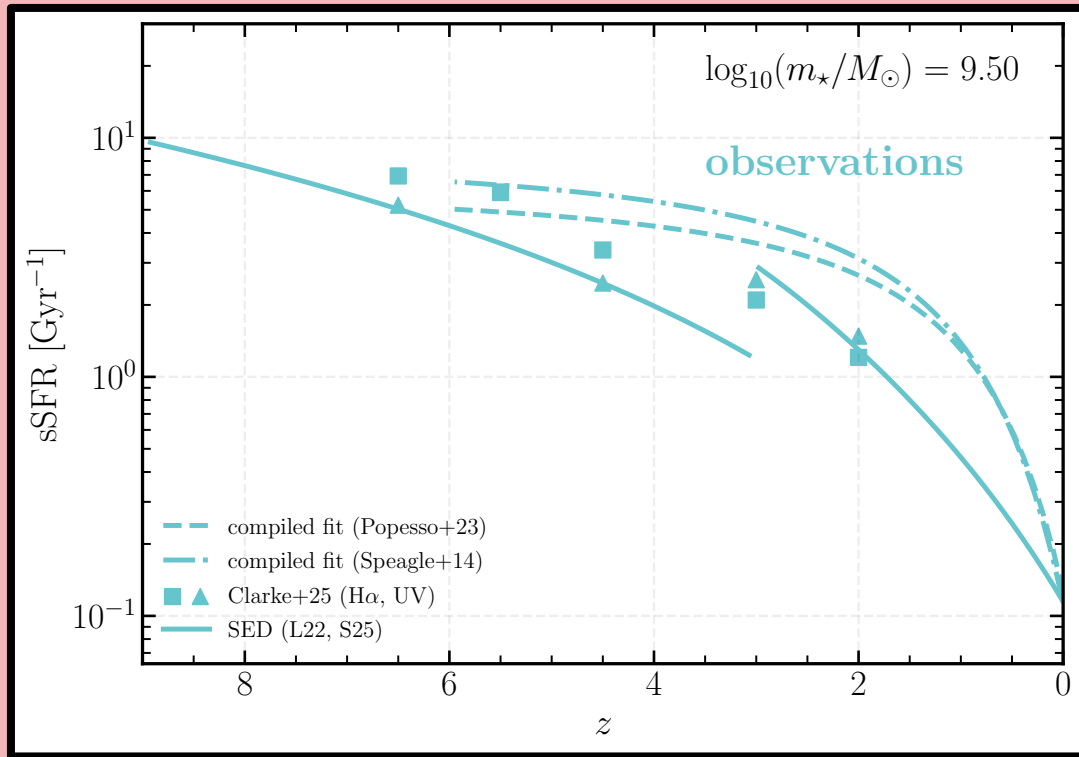
existing measurements **overestimate** the SMF



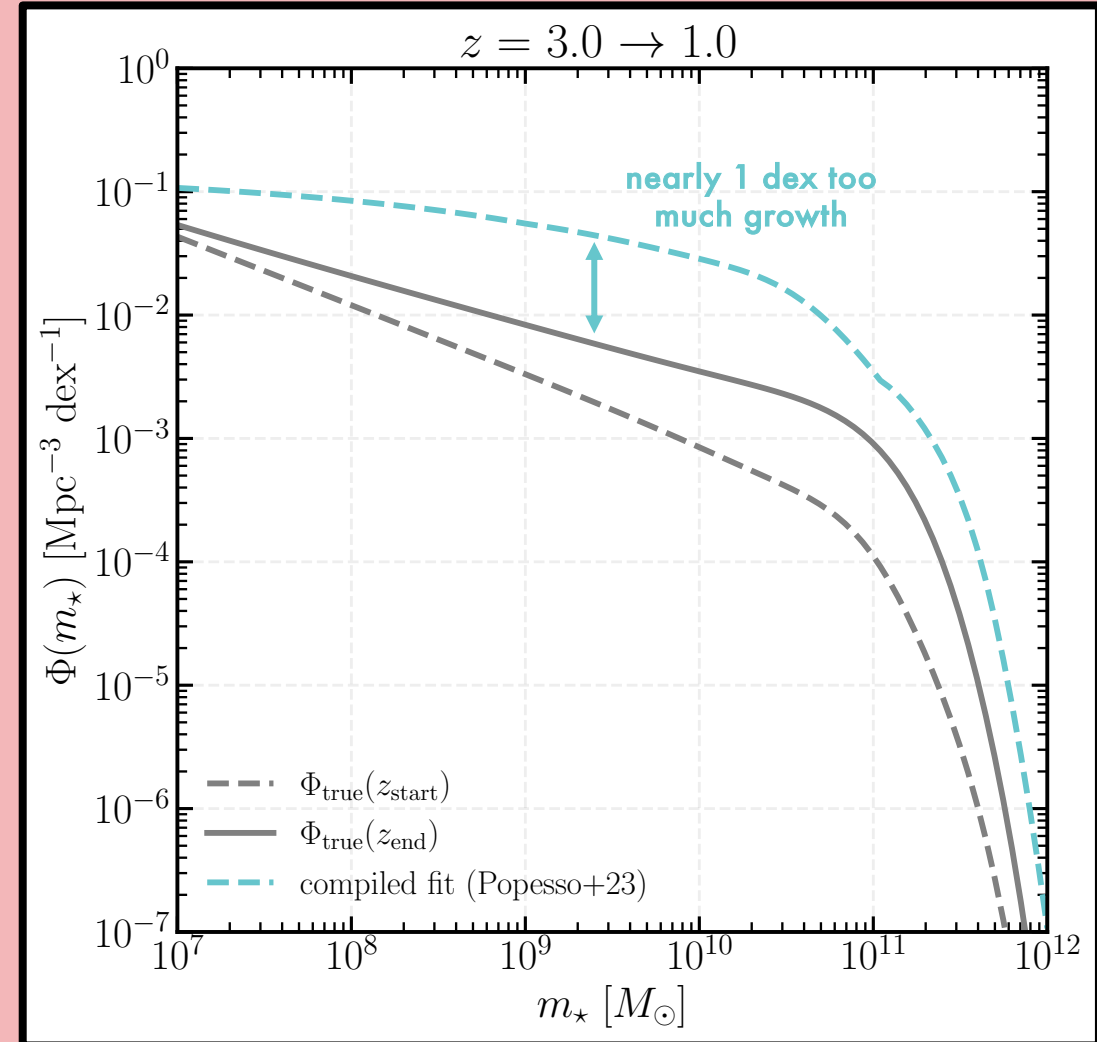
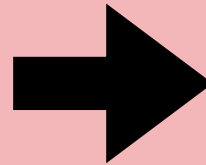
hegde, furlanetto & naoz (2026)



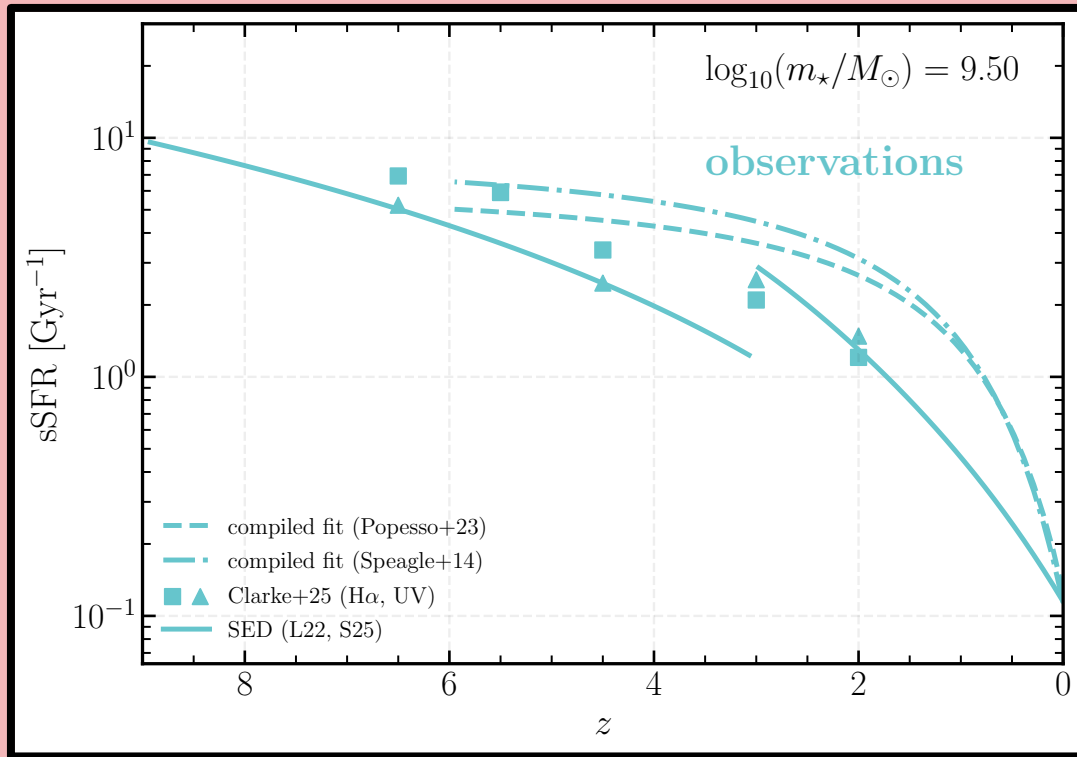
existing measurements **overestimate** the SMF



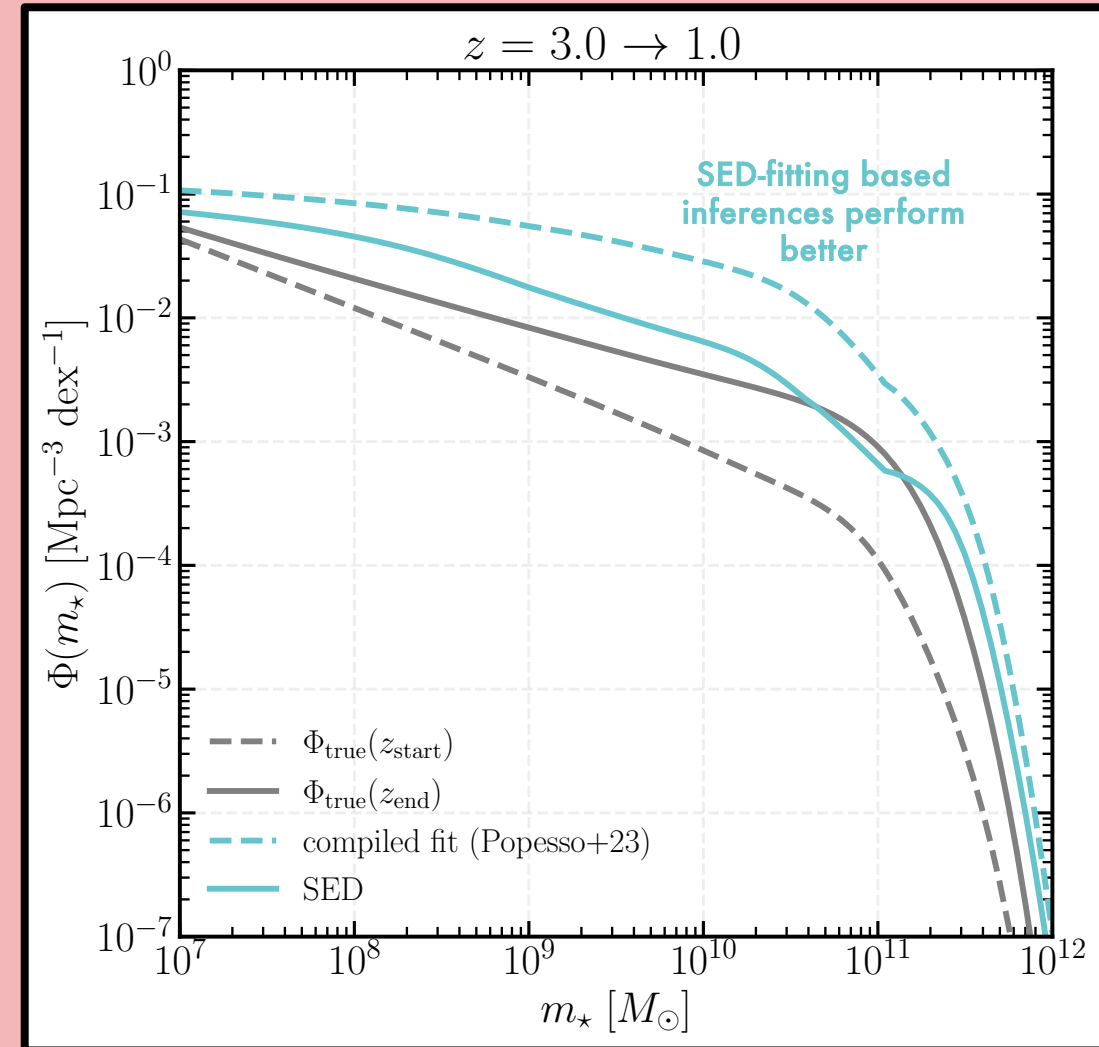
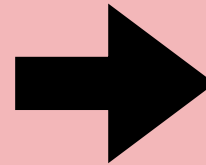
hegde, furlanetto & naoz (2026)



existing measurements **overestimate** the SMF

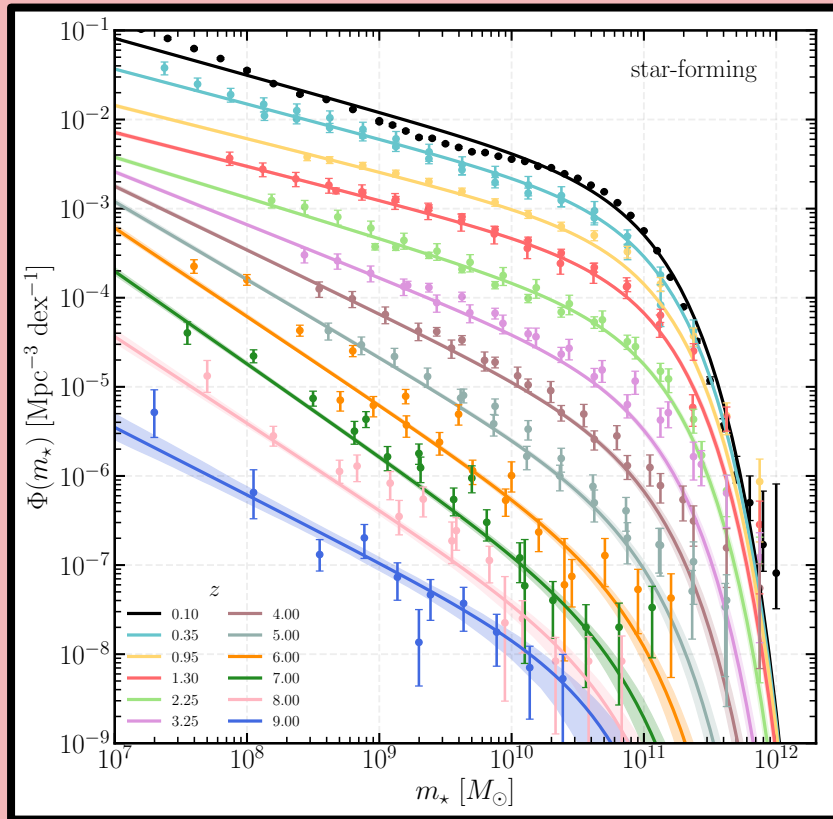


hegde, furlanetto & naoz (2026)

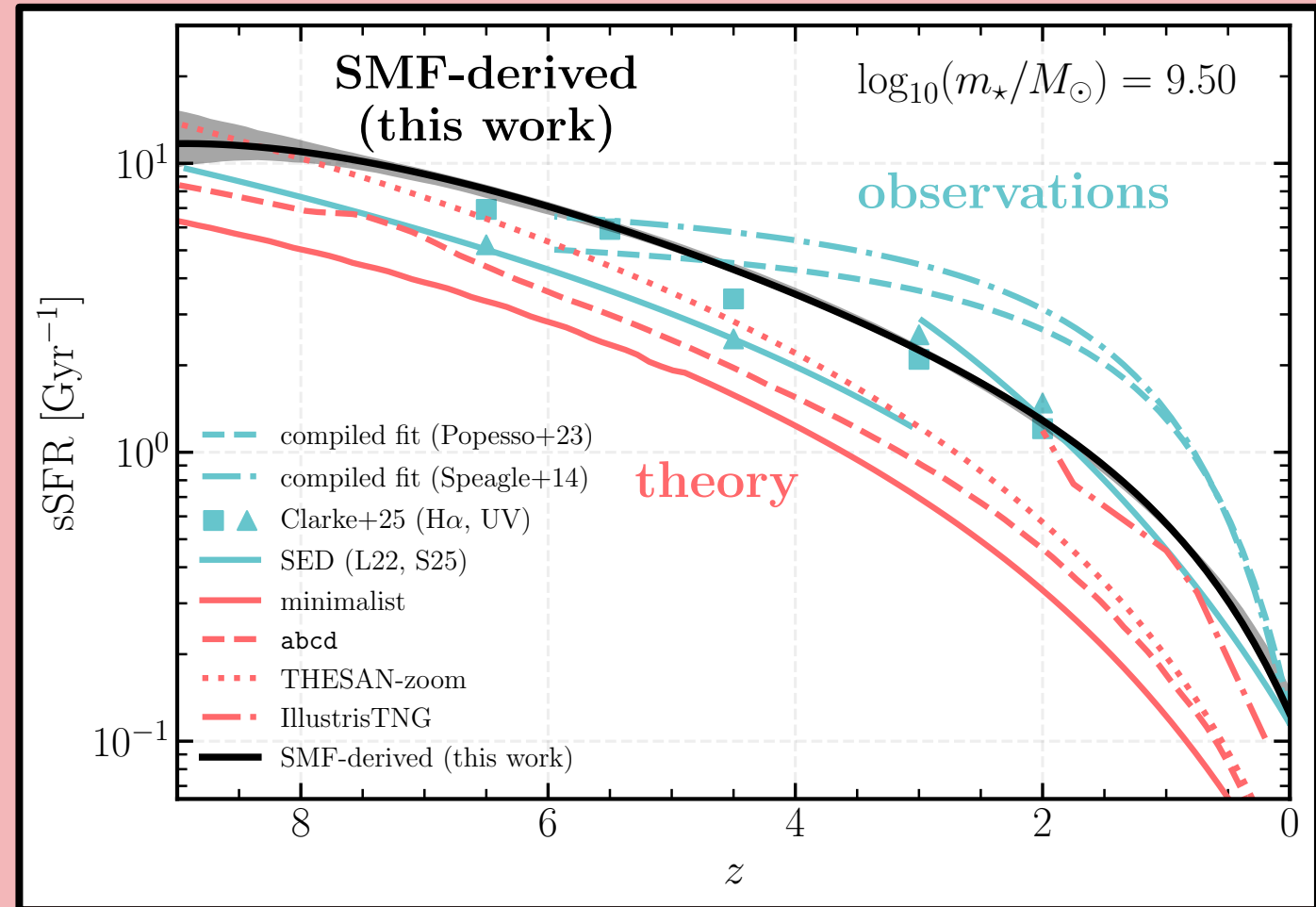
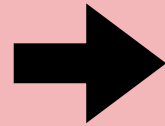


**what star formation rates
are **required** by the
stellar mass function?**

SMF-derived SFRs agree well with **independent** JWST measurements

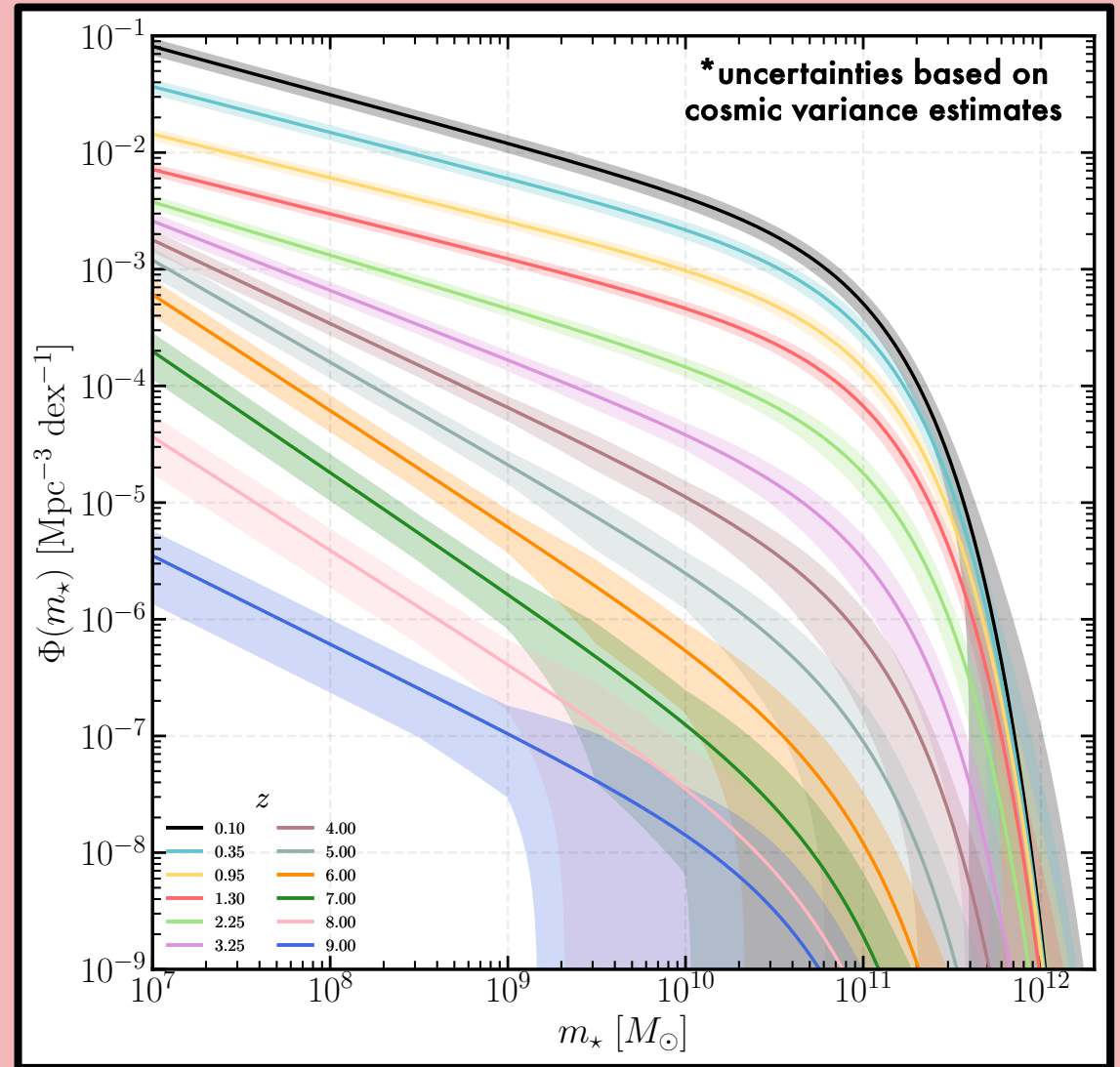


hegde, furlanetto & naoz (2026)



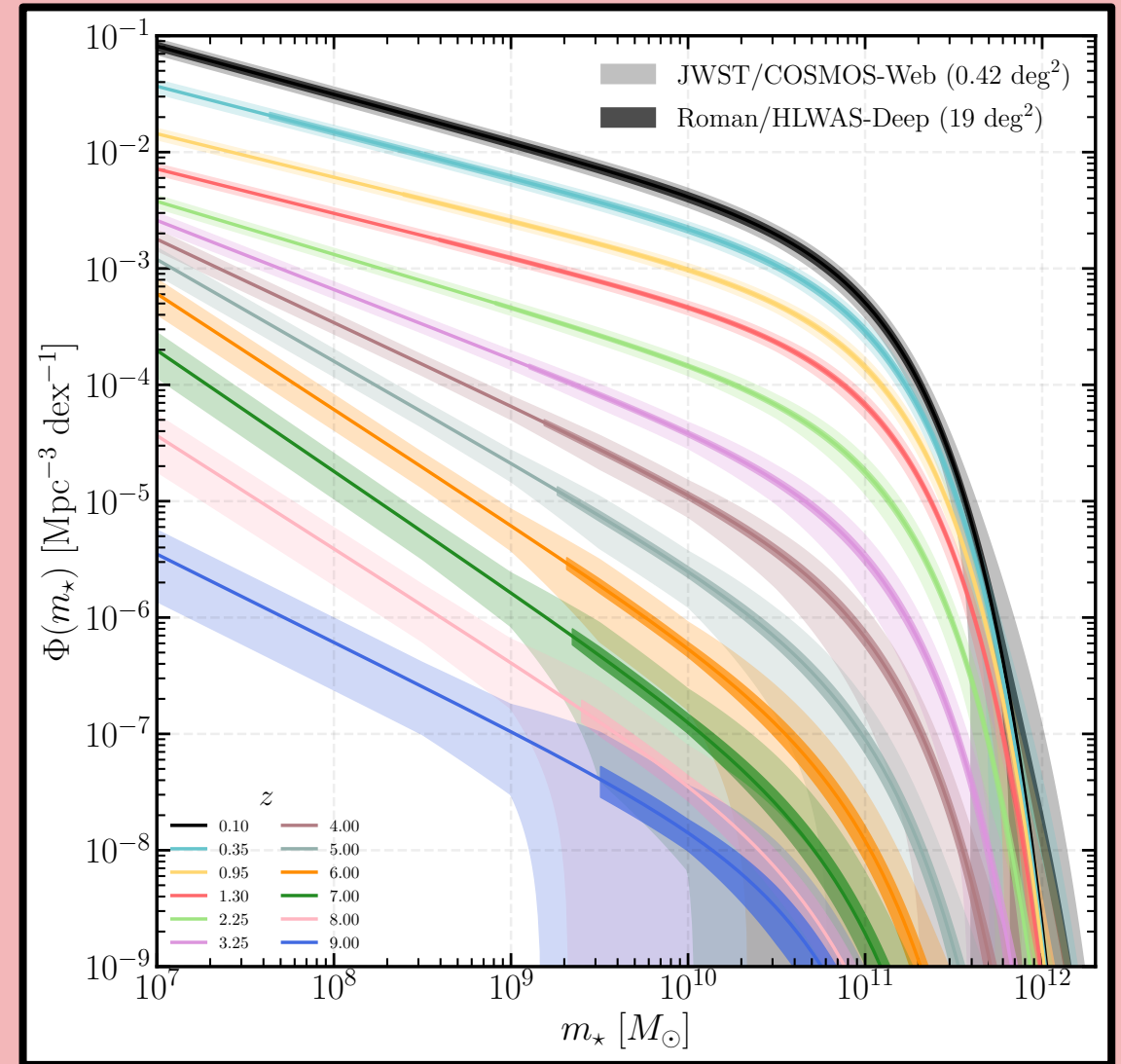
**but these mass
functions are
susceptible to
cosmic variance**

hegde, furlanetto & naoz (2026)



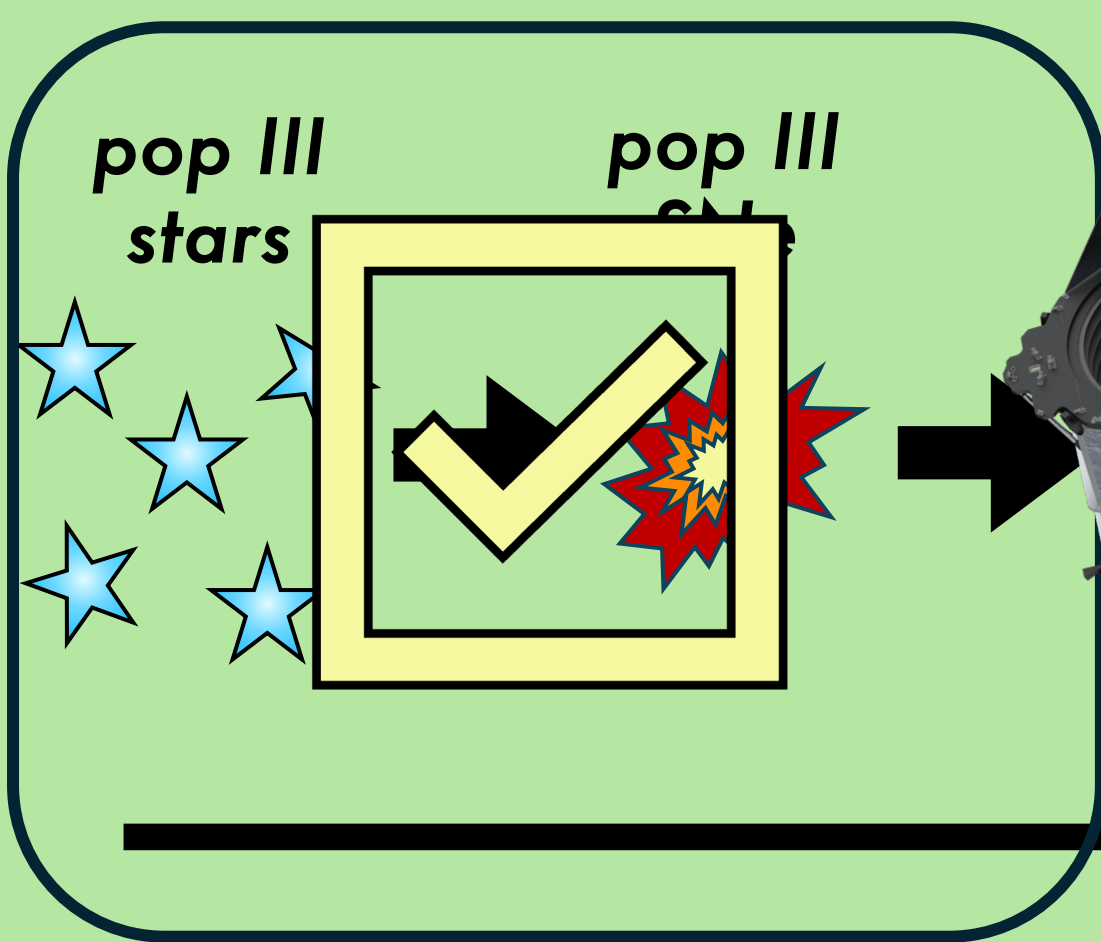
**and roman will
be much less
sensitive to
such effects**

hegde, furlanetto & naoz (2026)



part I

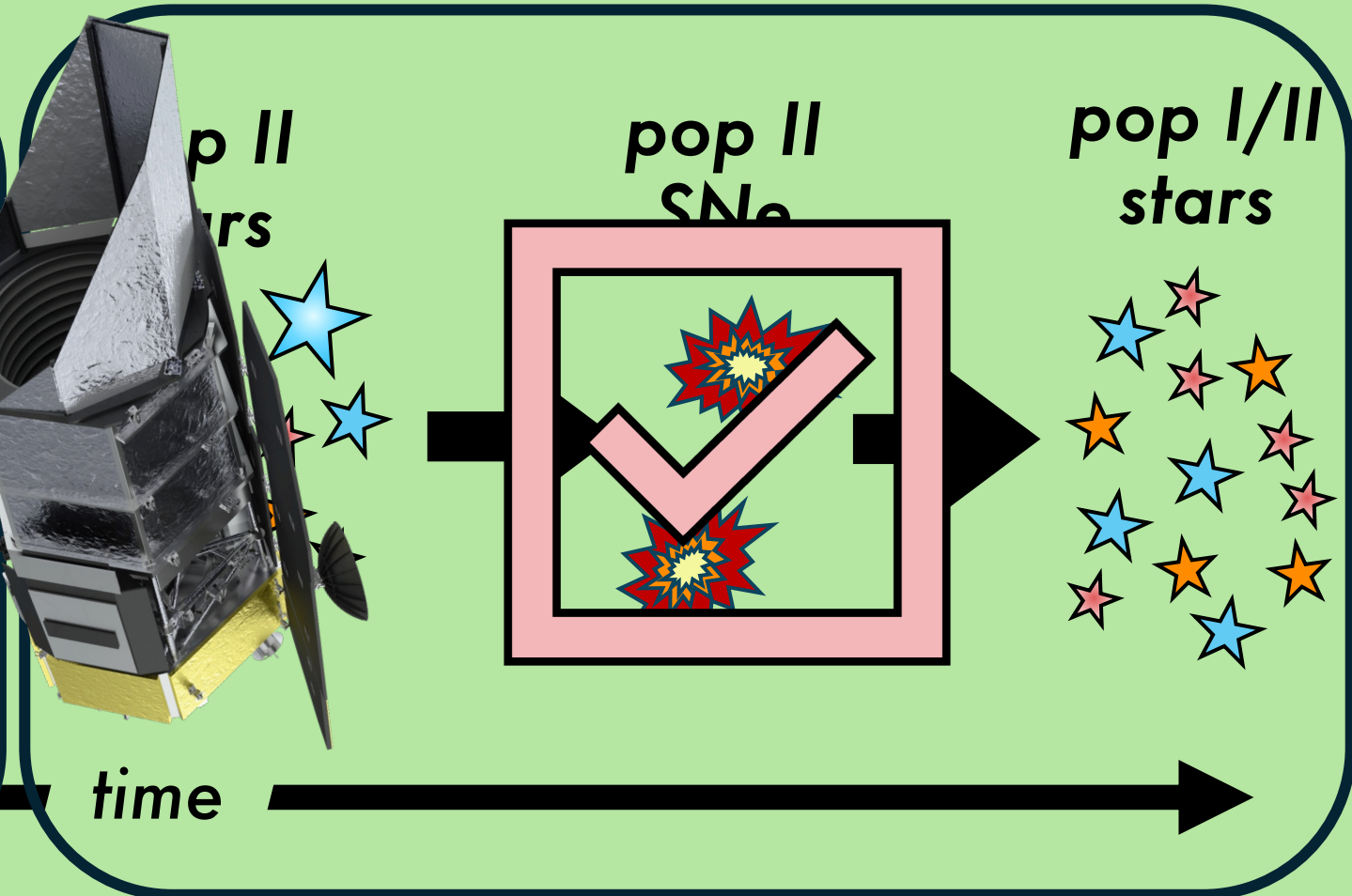
we don't have any constraints on the earliest phases of star formation



hegde & furlanetto (2023, 2025)

part II

there are longstanding uncertainties in our understanding of galaxies down to the local universe

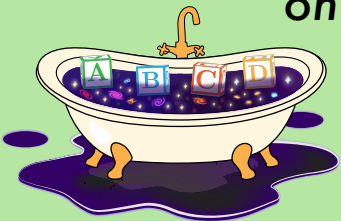


hegde, furlanetto & naoz (2026)



hegde & furlanetto (2025)

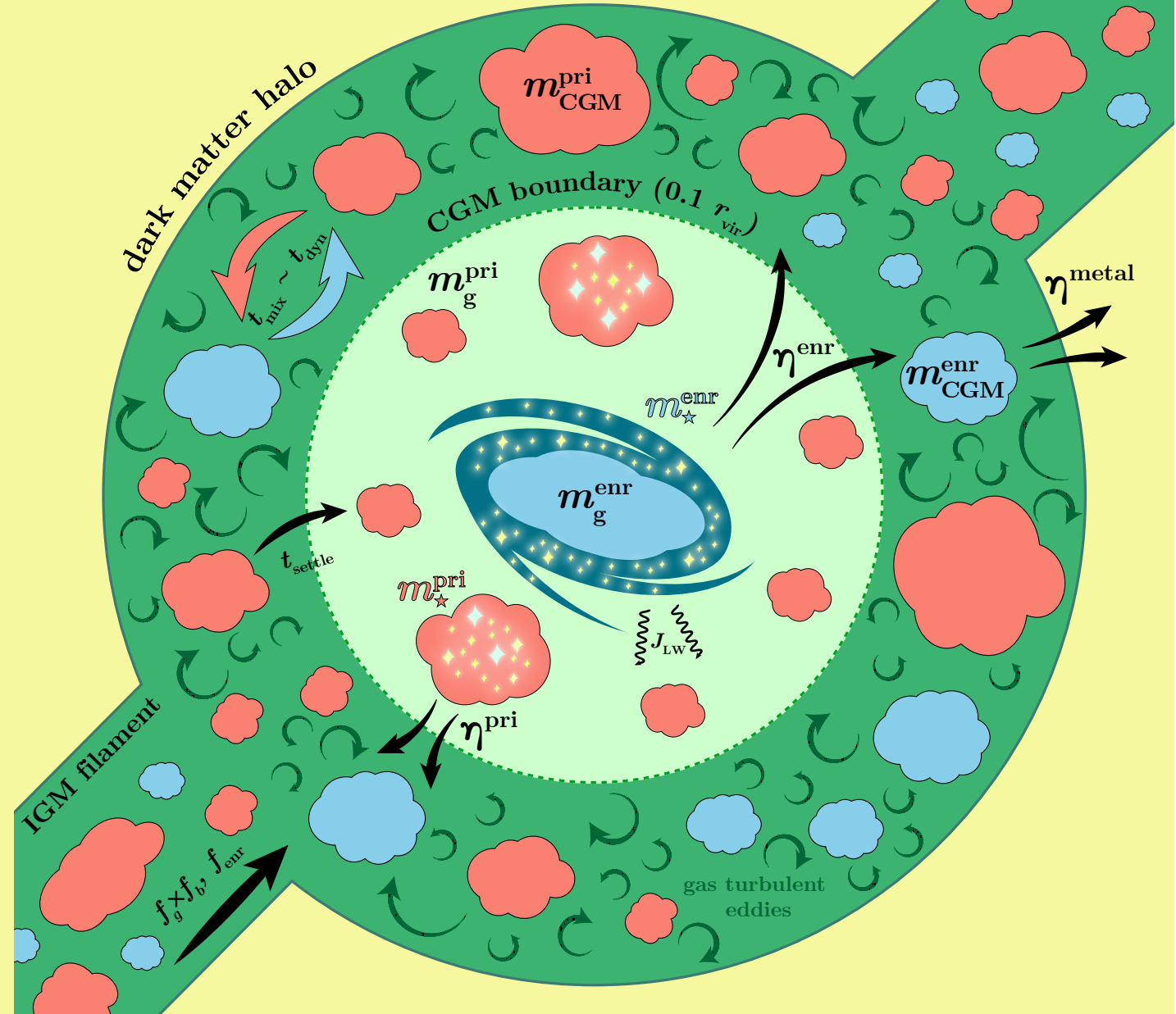
- we have a new, **flexible** framework to trace pop III and II star formation across time
- pop III star formation persists to the end of reionization
- roman could measure a **statistical** number of pop III transients and place constraints on the IMF



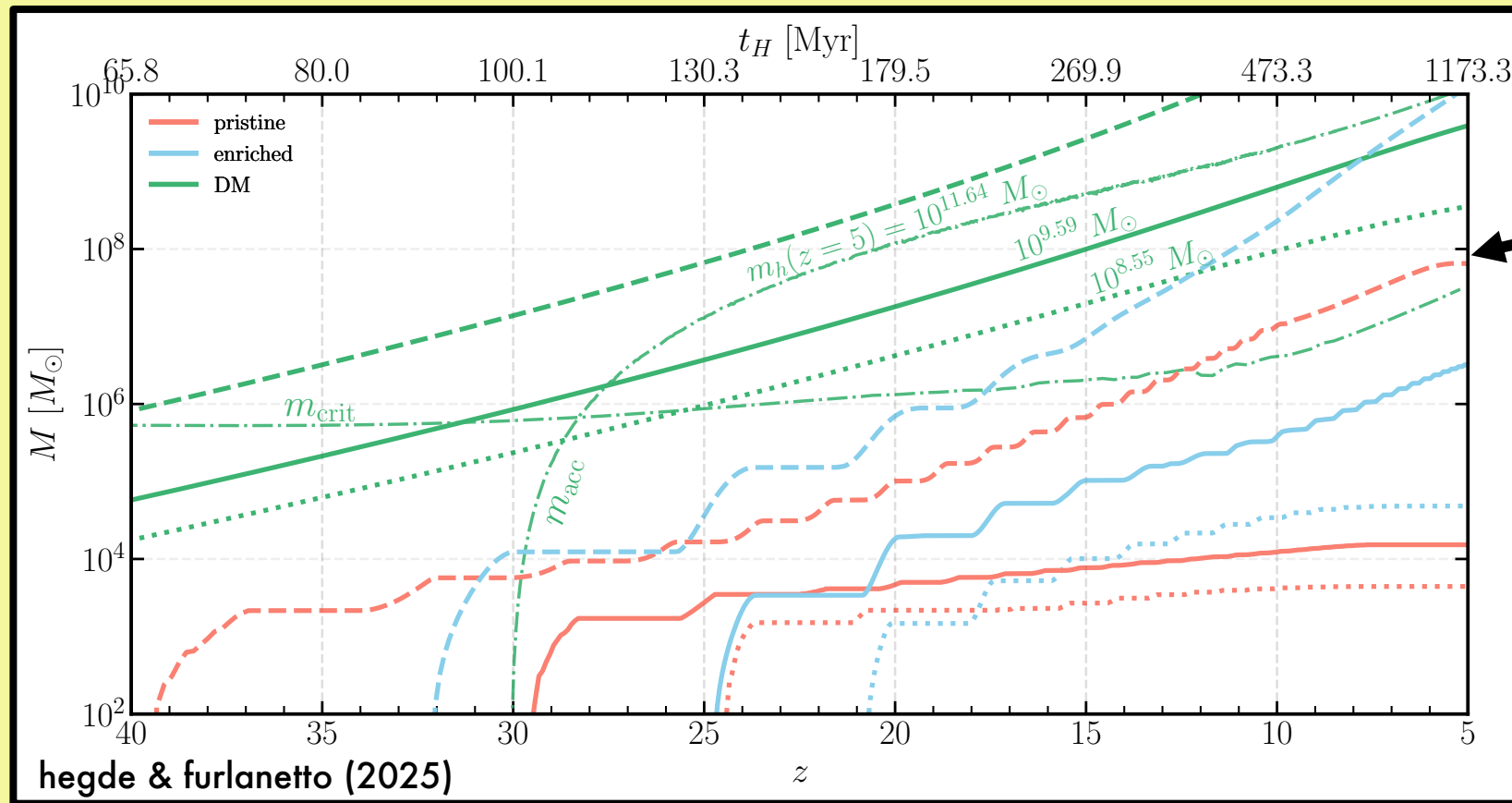
hegde, furlanetto & naoz (2026)

- there are **systematic uncertainties** in fundamental galaxy scaling relations
- the evolution of the stellar mass function could help reconcile these uncertainties
- our SMF-derived star formation rates **agree very well** with JWST measurements
- wide-area galaxy surveys with Roman are **necessary** for such analyses to be robust to field-to-field variations in galaxy counts

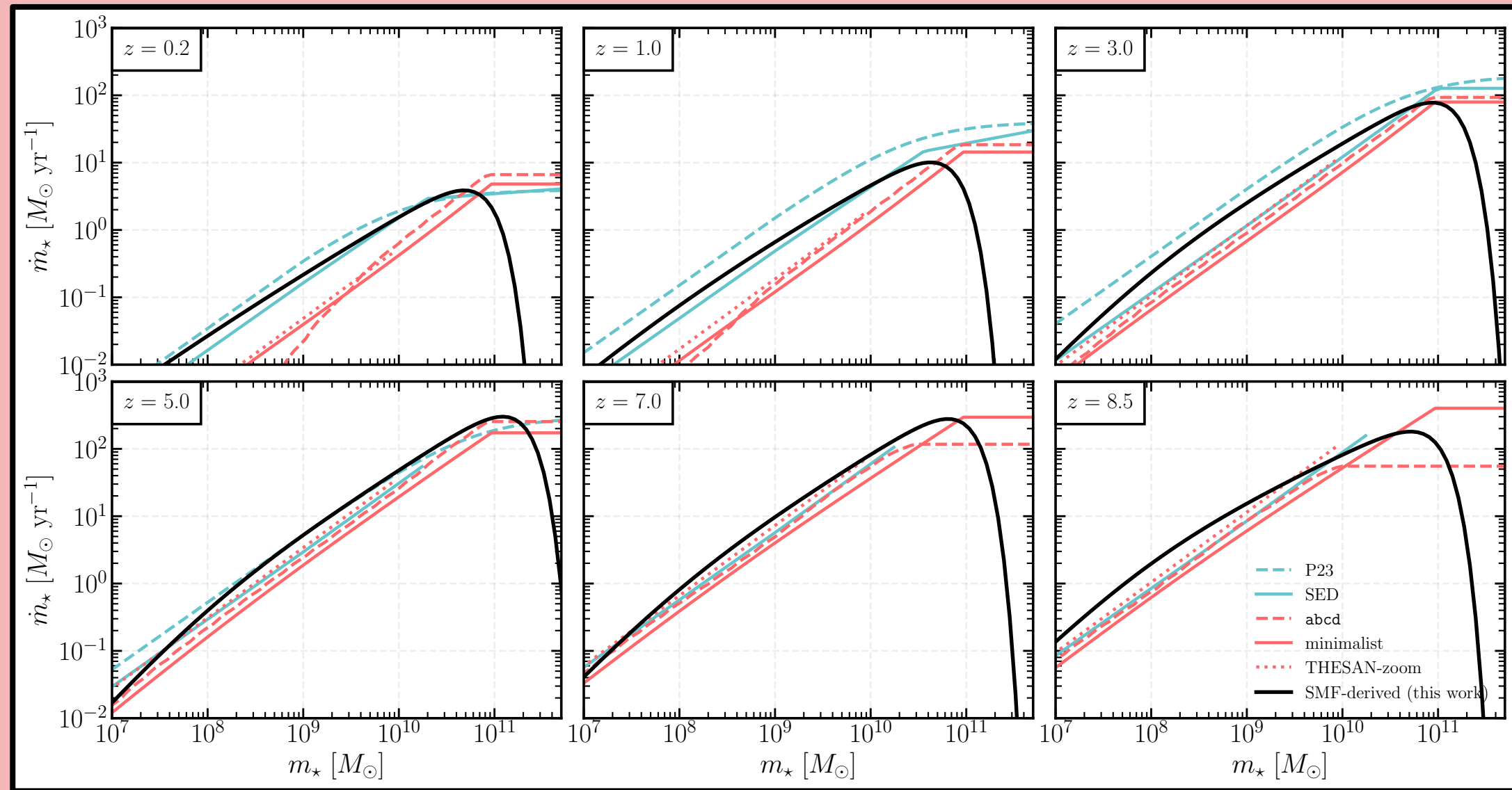
extra

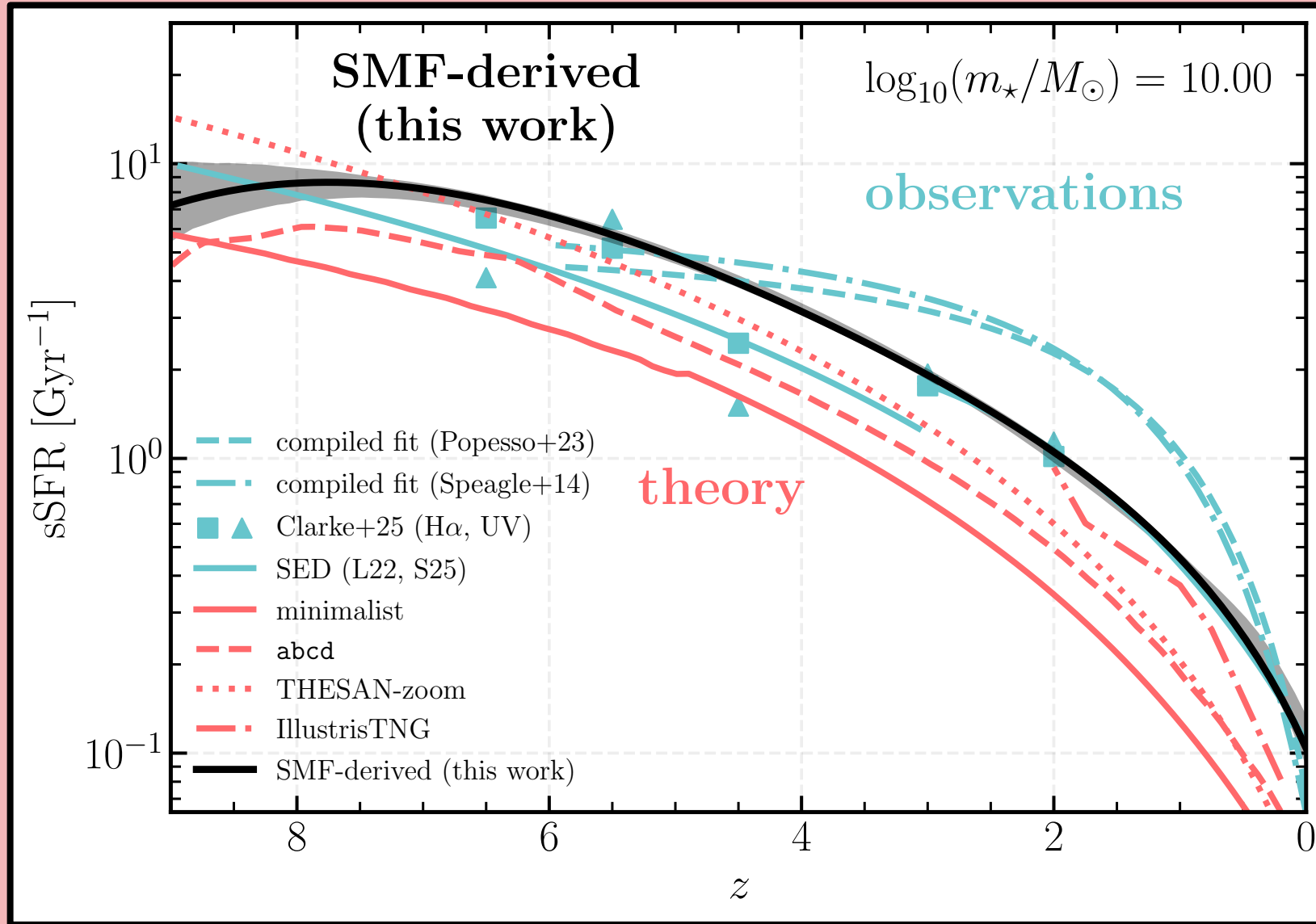


star formation histories vary **significantly** between halos of different masses



ongoing pristine
star formation
only in the most
massive galaxies





**and roman will
be much less
sensitive to
such effects**

hegde, furlanetto & naoz (2026)

