arXiv:1207.6105

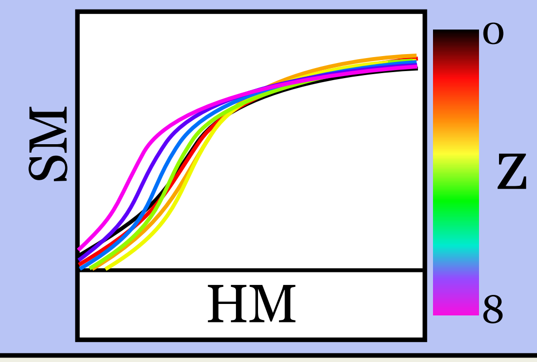
STAR FORMATION HISTORIES OF GALAXIES FROM Z=0-8

Picture Credit: John Davis

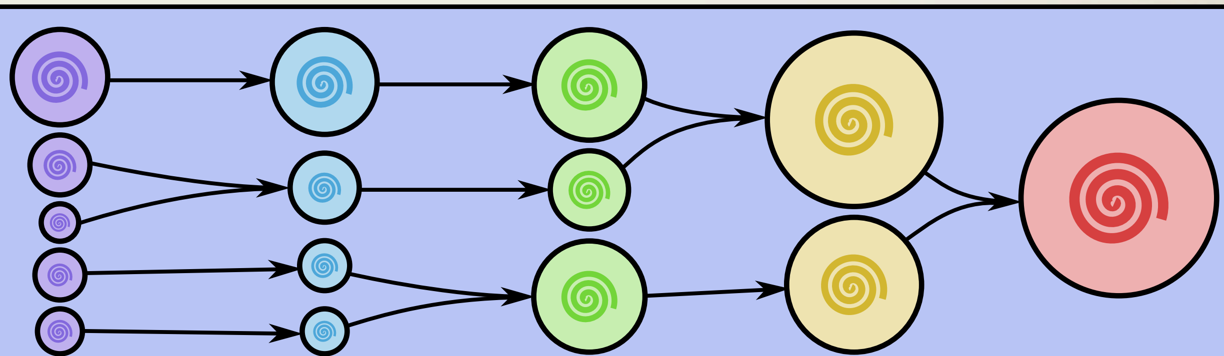
Peter Behroozi, Stanford University / KIPAC
Risa Wechsler and Charlie Conroy

Basic Approach

1. Choose a stellar mass - halo mass (SMHM) relation from parameter space.

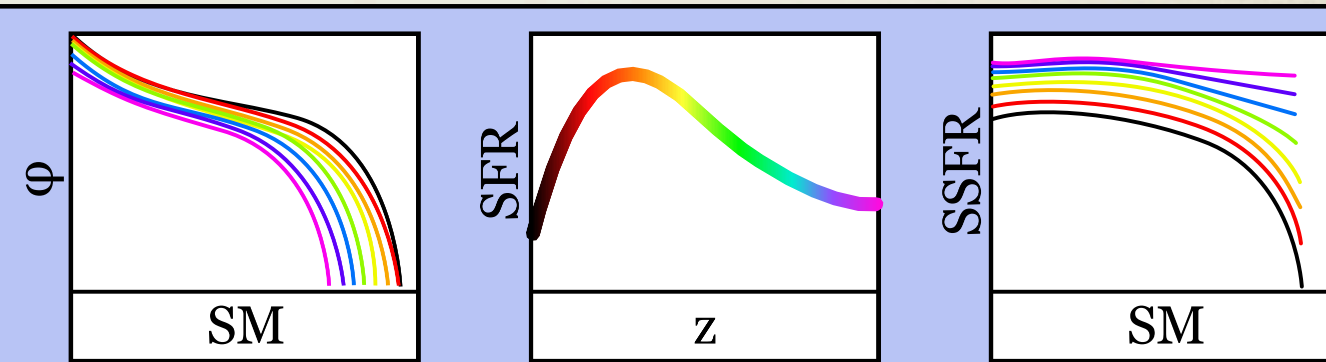


2. Find galaxy growth histories by applying the SMHM relation to dark matter merger trees.

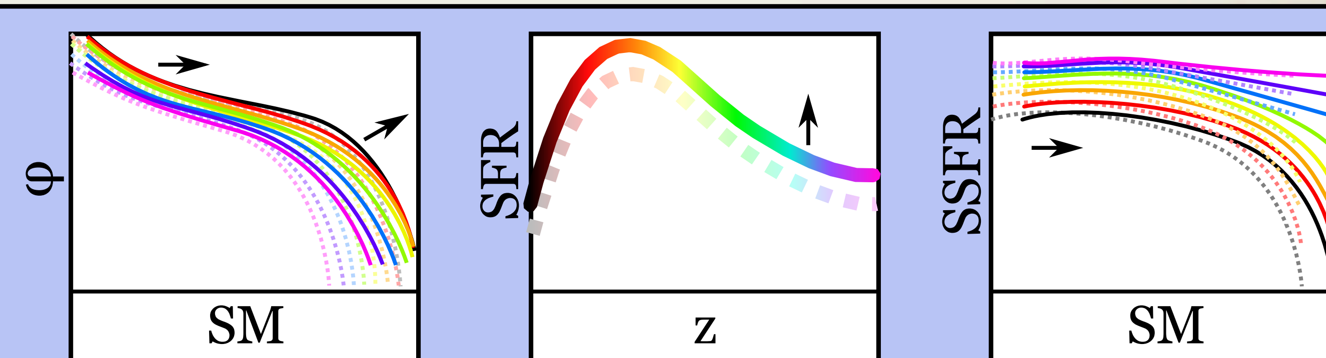


Basic Approach

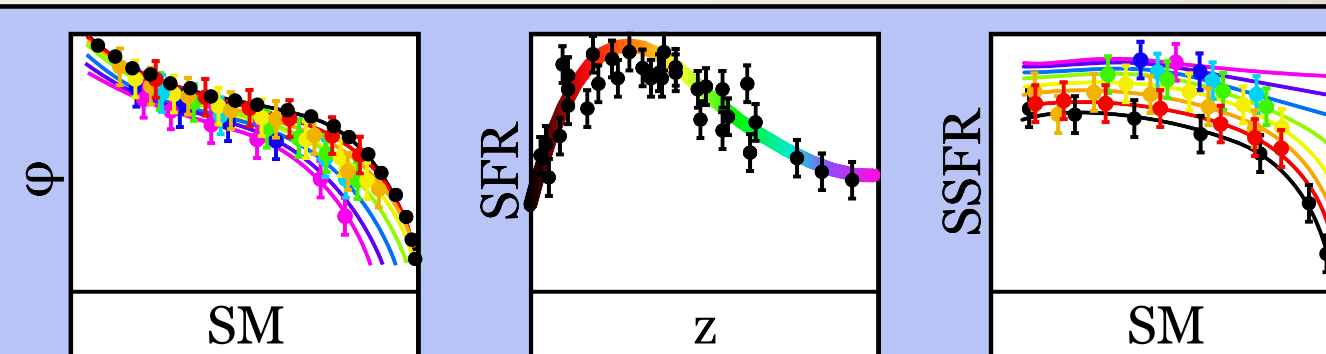
3. Derive the inferred stellar mass functions and star formation rates.



4. Apply effects to simulate observational errors and biases.



5. Compare to data and calculate likelihood of the chosen SMHM relation.



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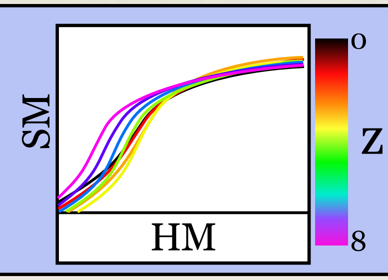

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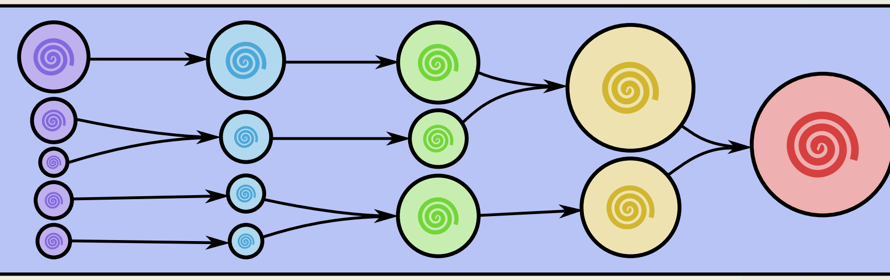

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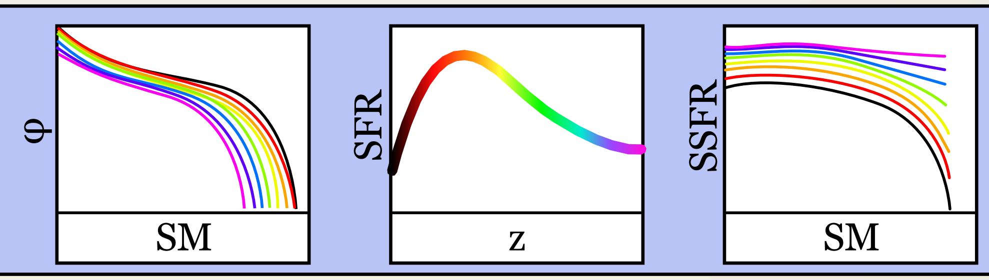

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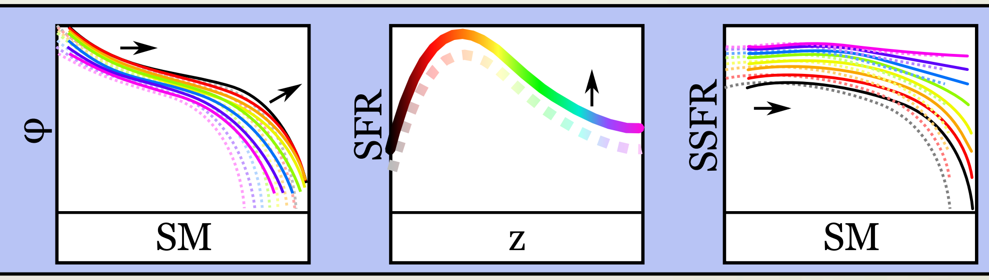

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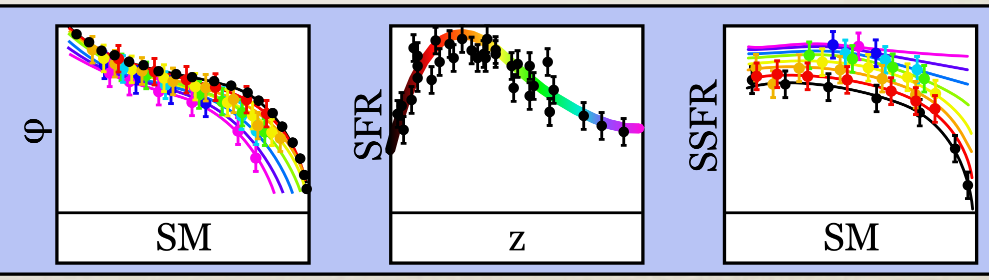
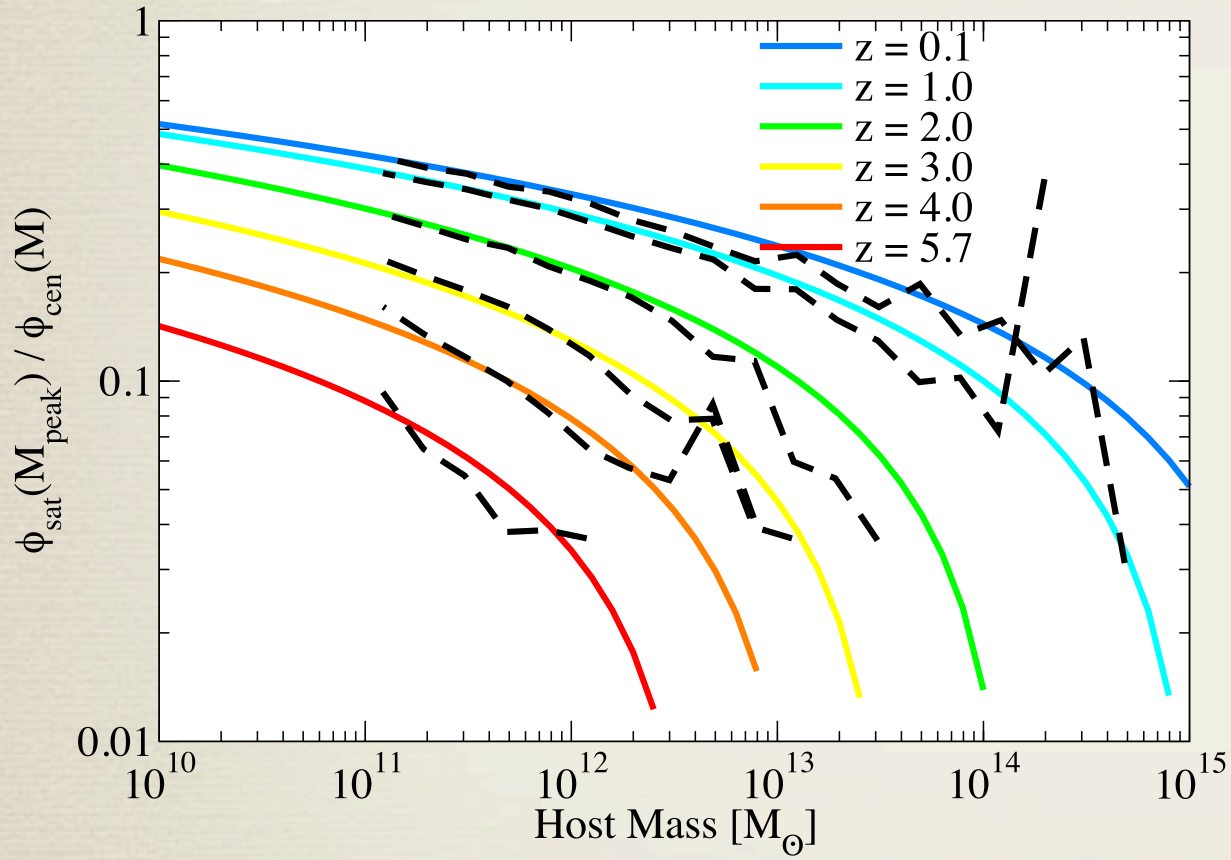
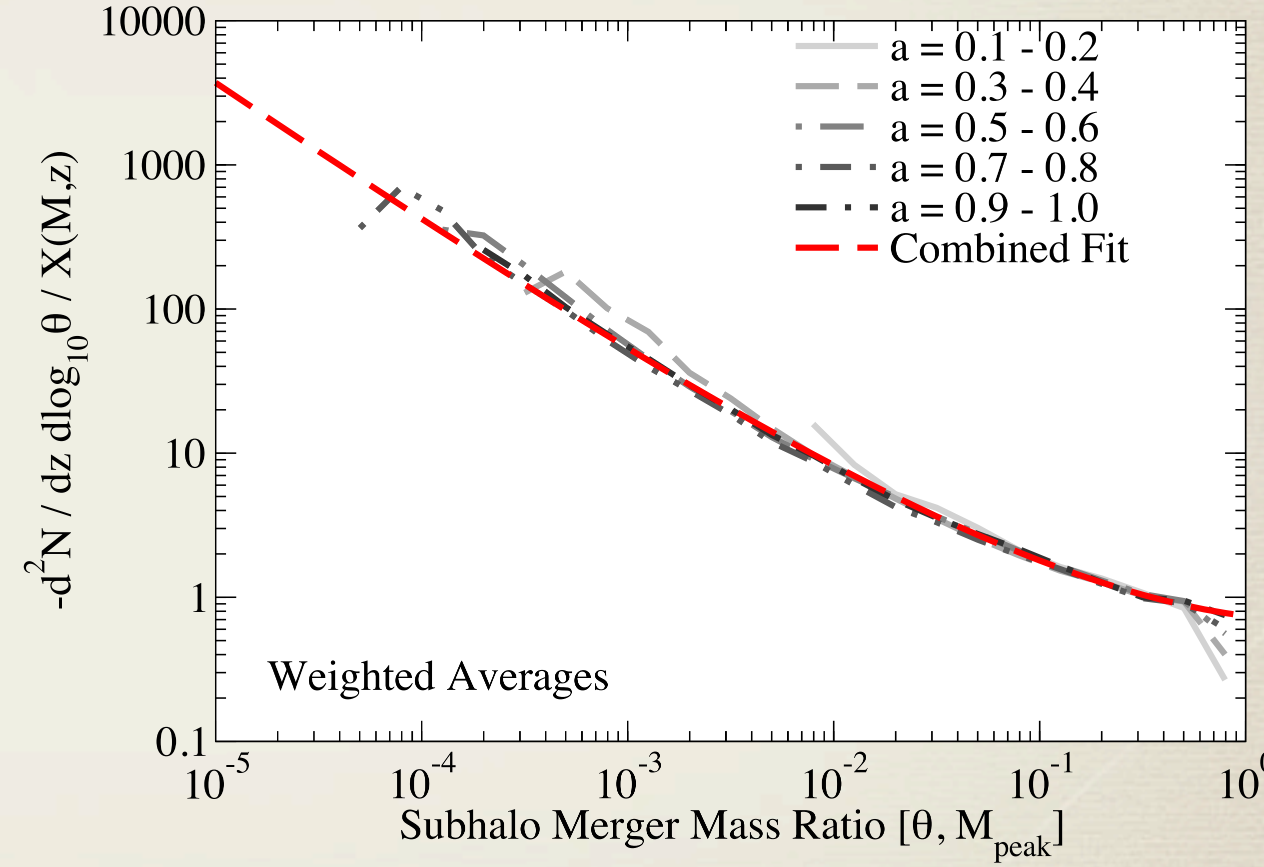


Repeat as often as necessary to explore allowable solutions.

Basic Approach

Data Sets:





New calibrations of halo mass functions, satellite fractions, and merger rates to z=8 from Bolshoi.

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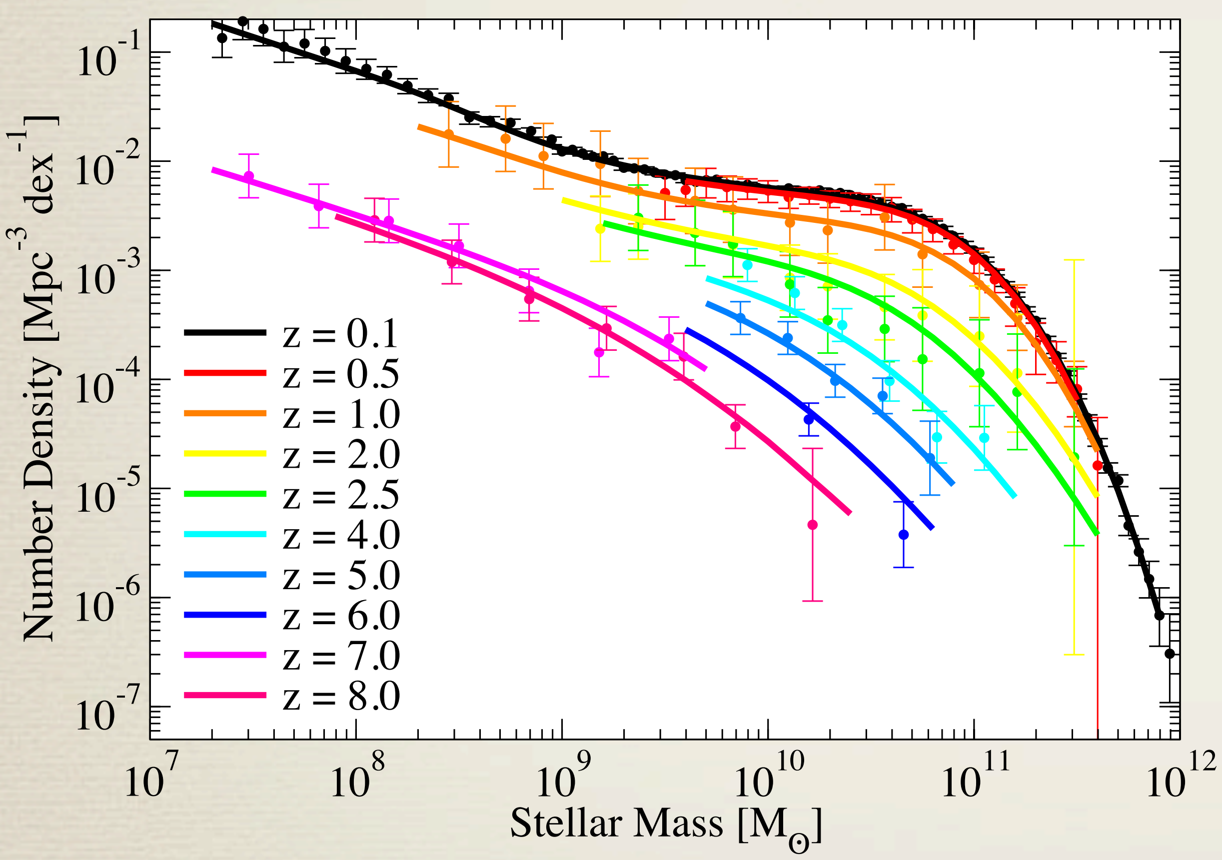
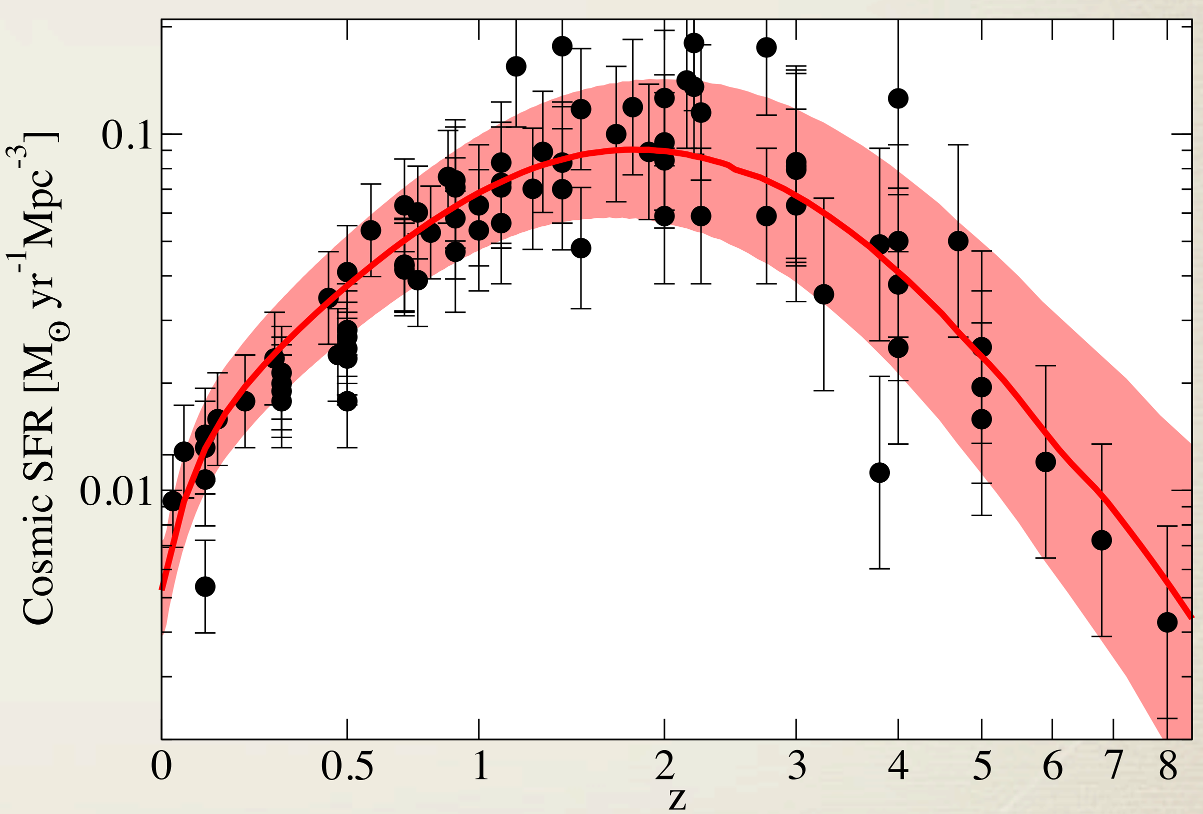
Basic Approach

Data Sets:



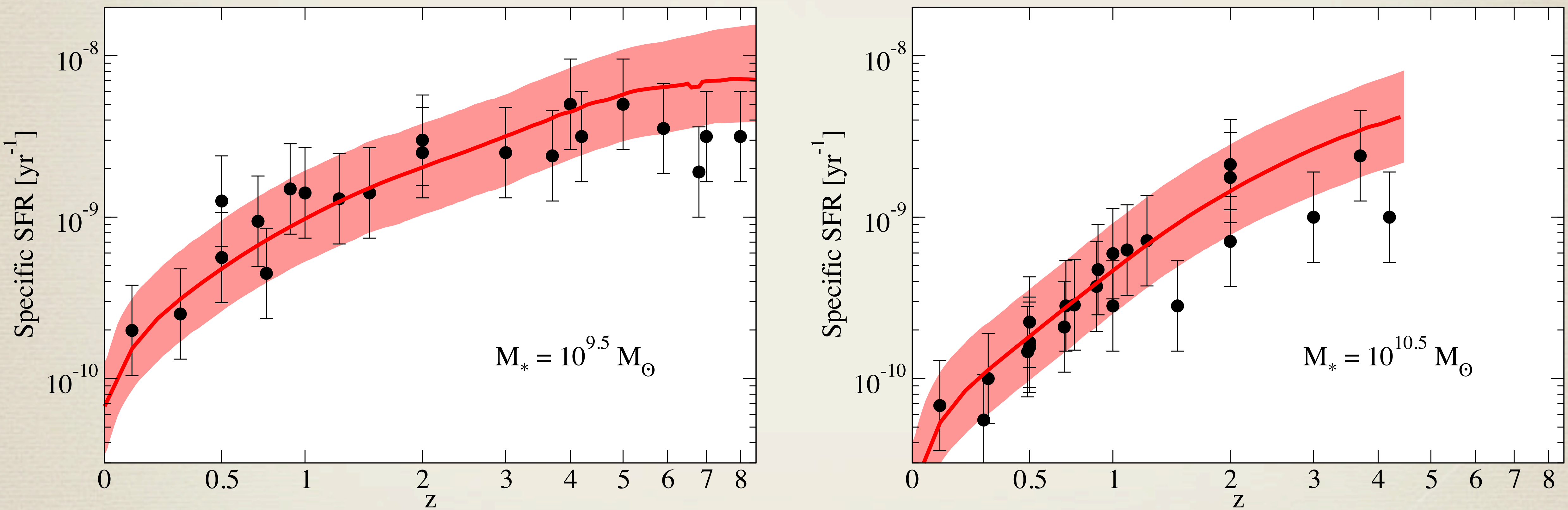
New Stellar Mass Functions from PRIMUS, others up to z=8



New compilation of cSFRs to z=8

Basic Approach

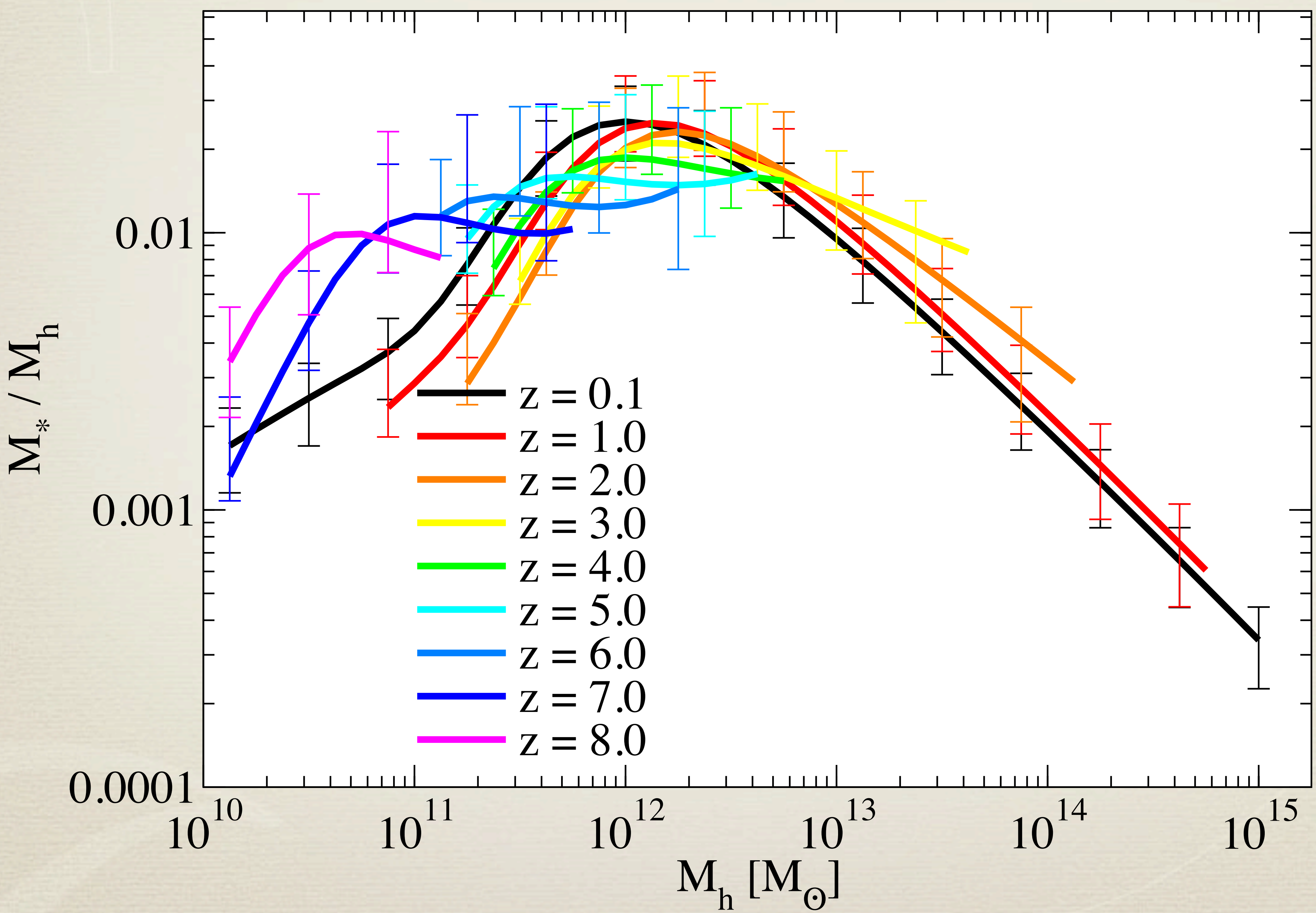
Data Sets:



and SSFRs too!

Results

Constraints on the M*/Mh ratio, useful for SAMs and hydro:



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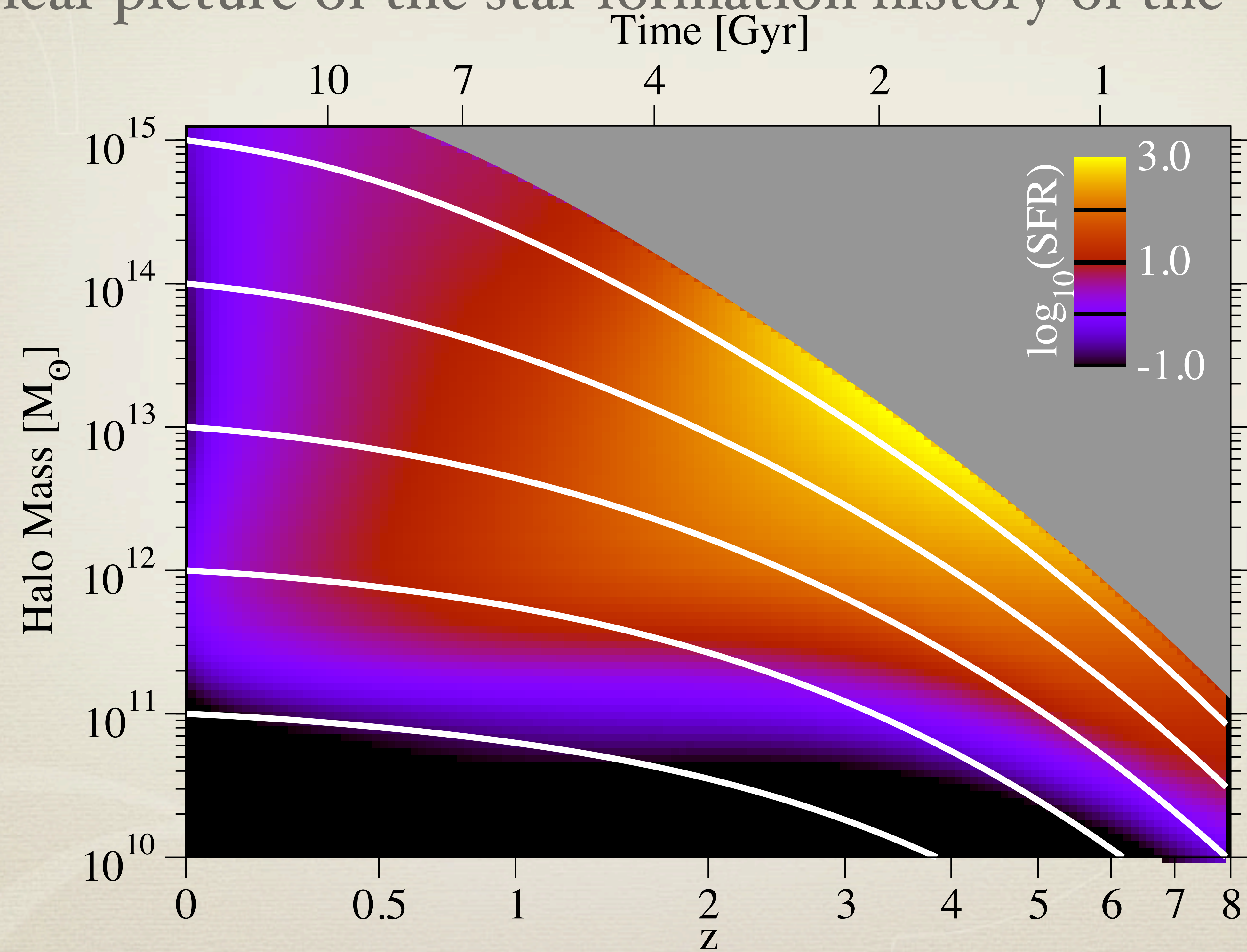
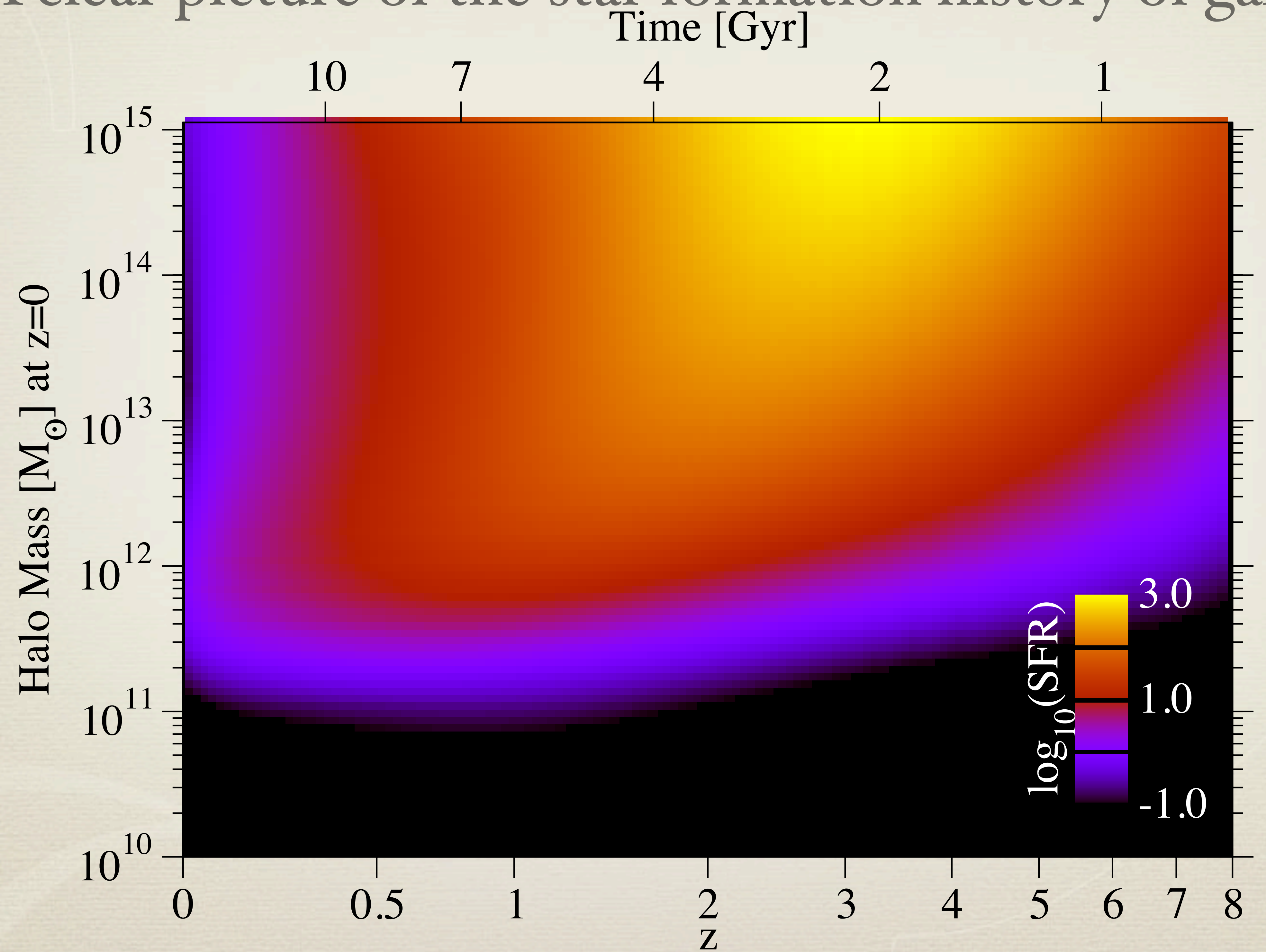
Results

A clear picture of the star formation history of the Universe:



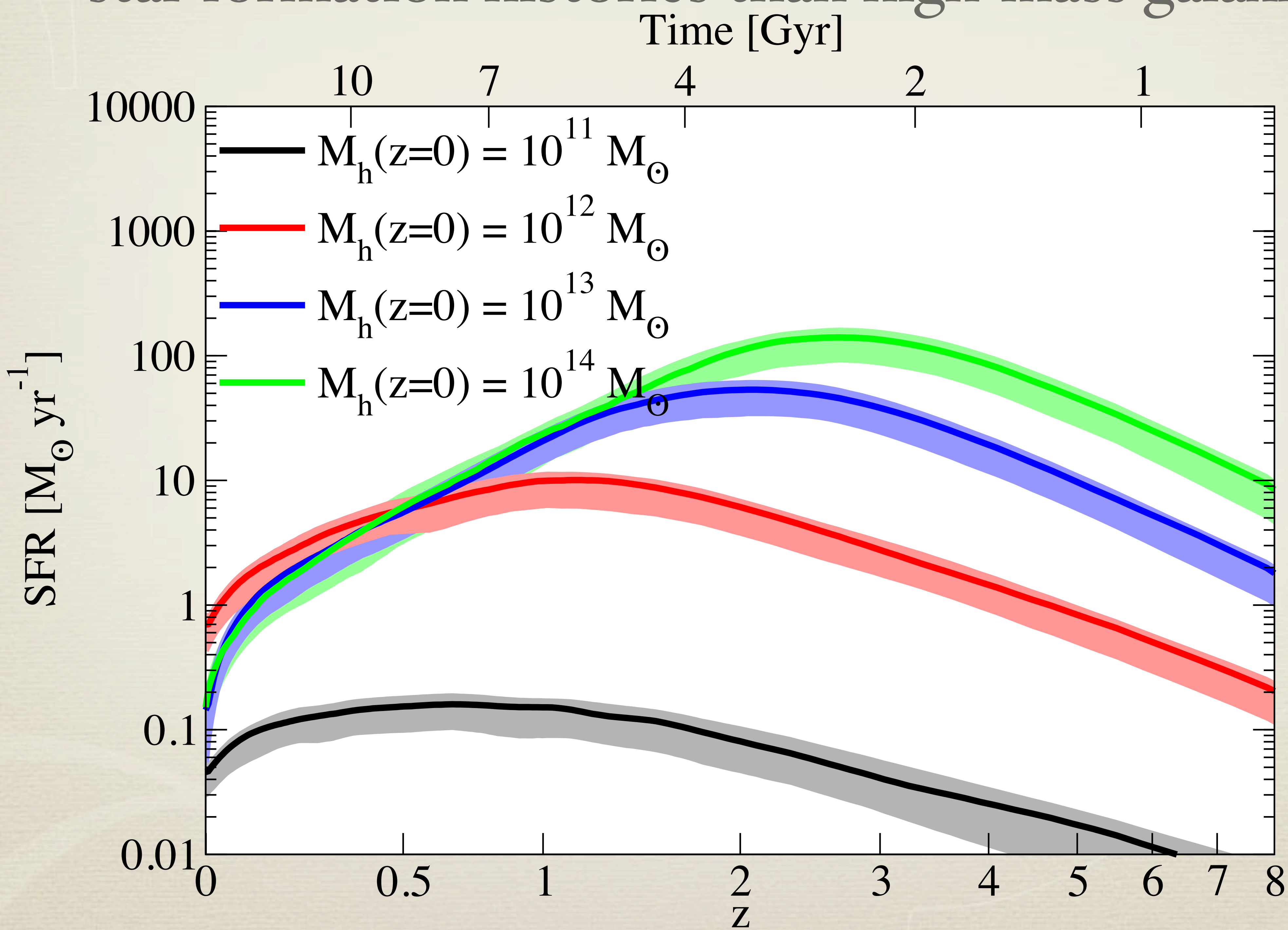
Results

A clear picture of the star formation history of galaxies:



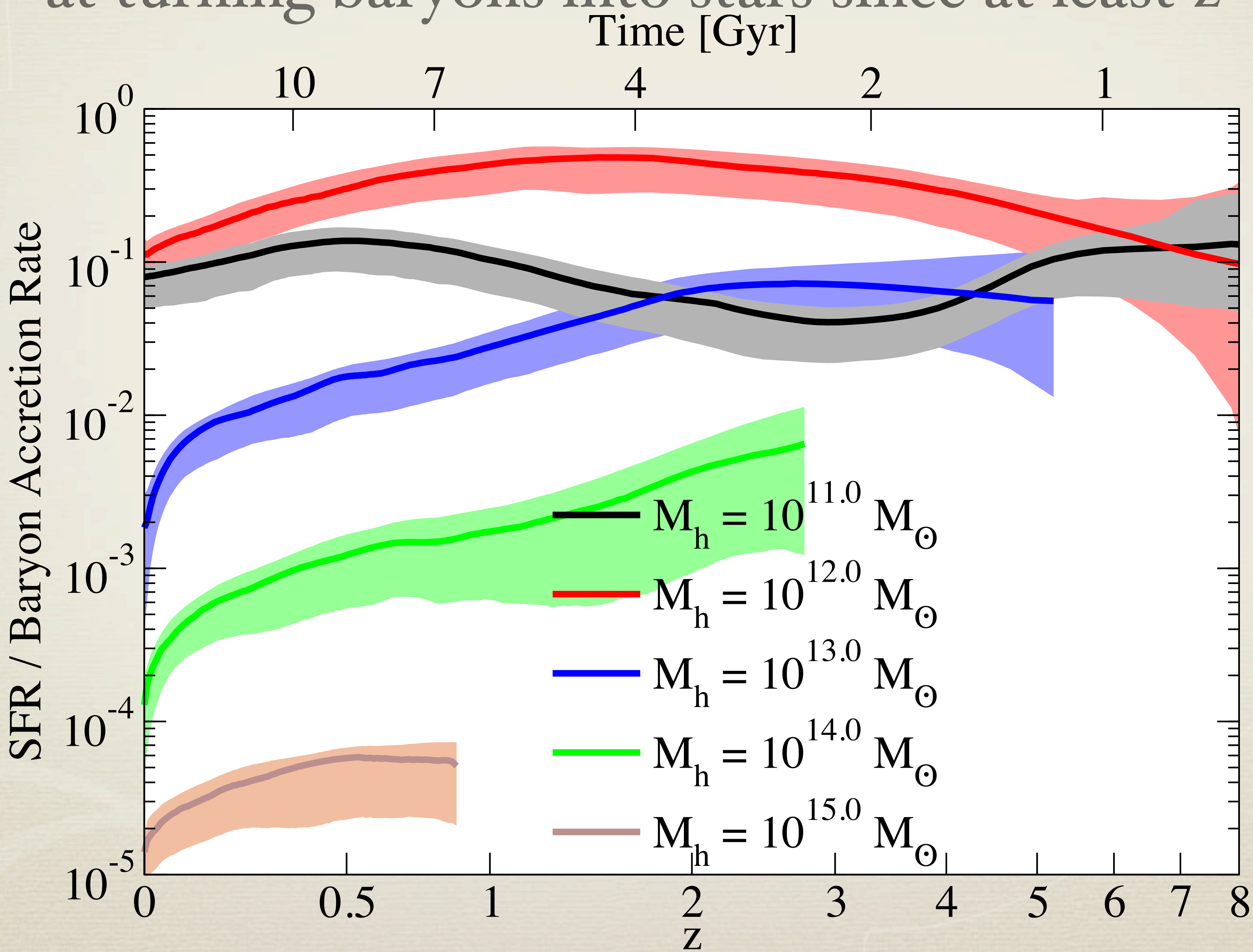
Results

Low-mass galaxies have had significantly different star formation histories than high-mass galaxies



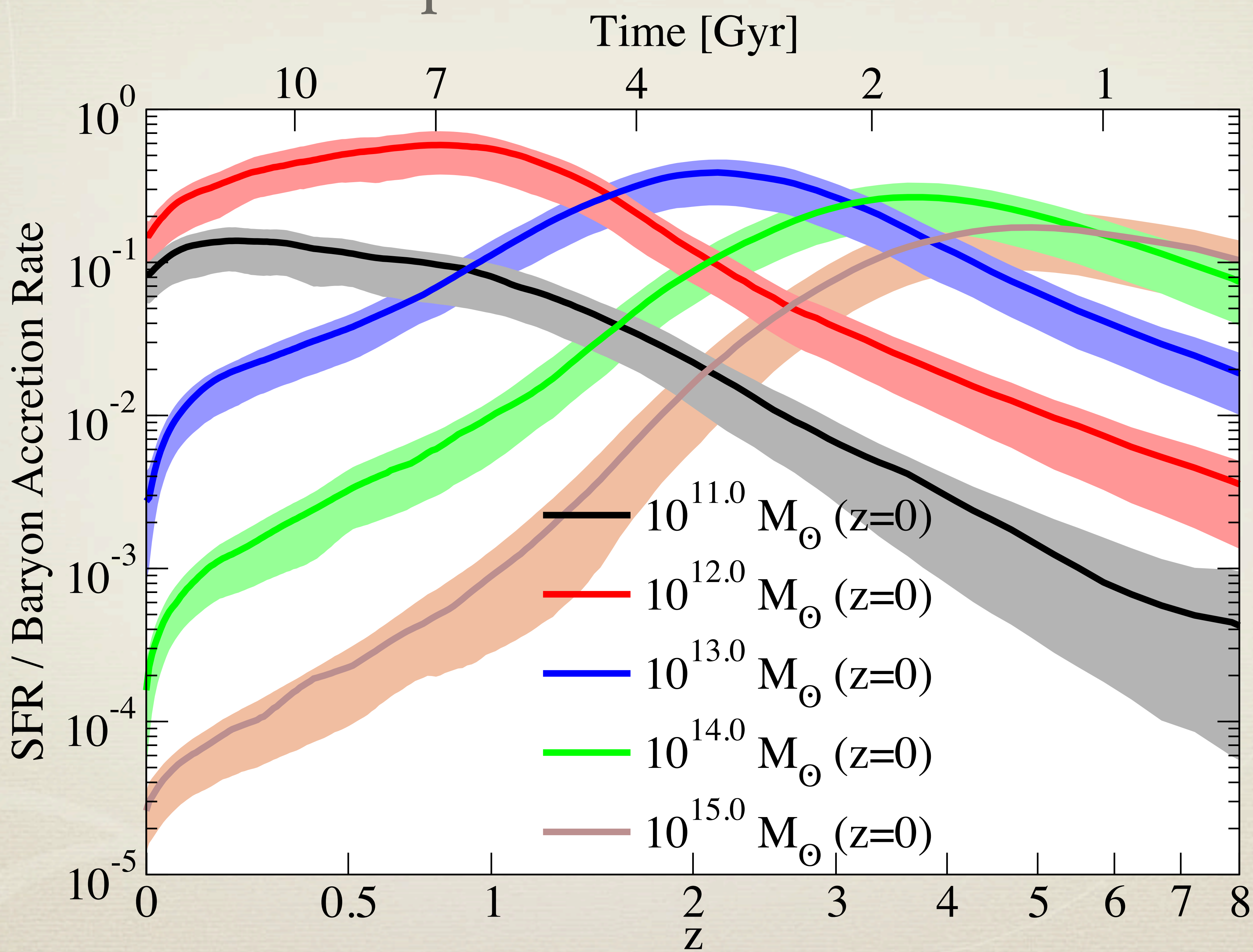
Results

Milky-Way-sized halos have been the most efficient at turning baryons into stars since at least z=8



Results

This leaves a clear imprint on the historical conversion ratio:



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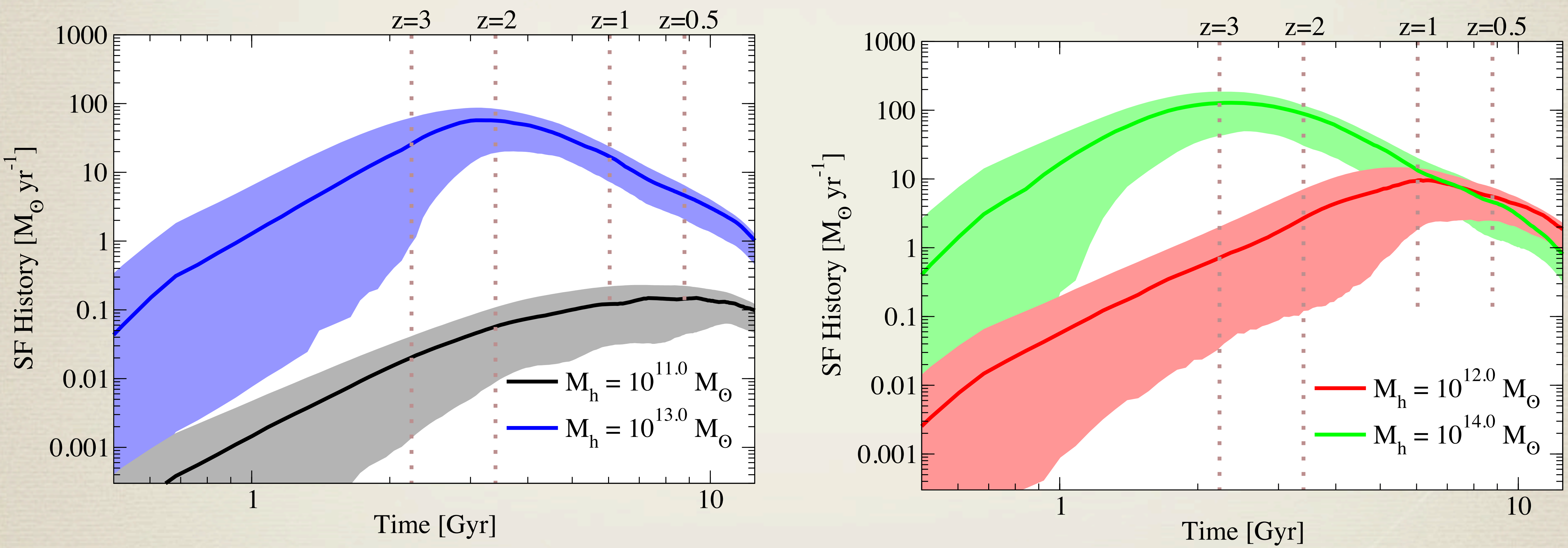
High-Redshift Histories

Constraints on Individual Star Formation Histories



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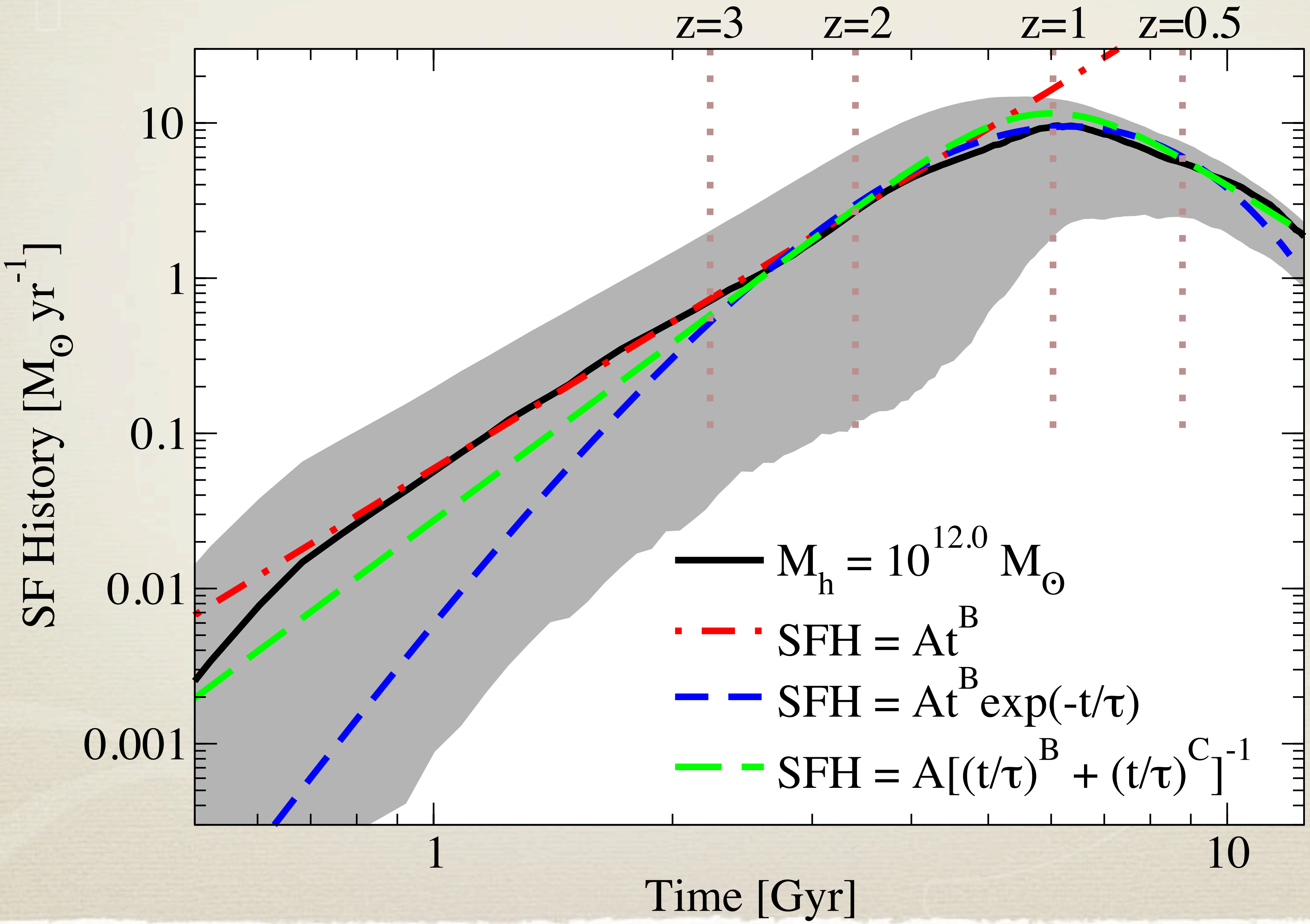

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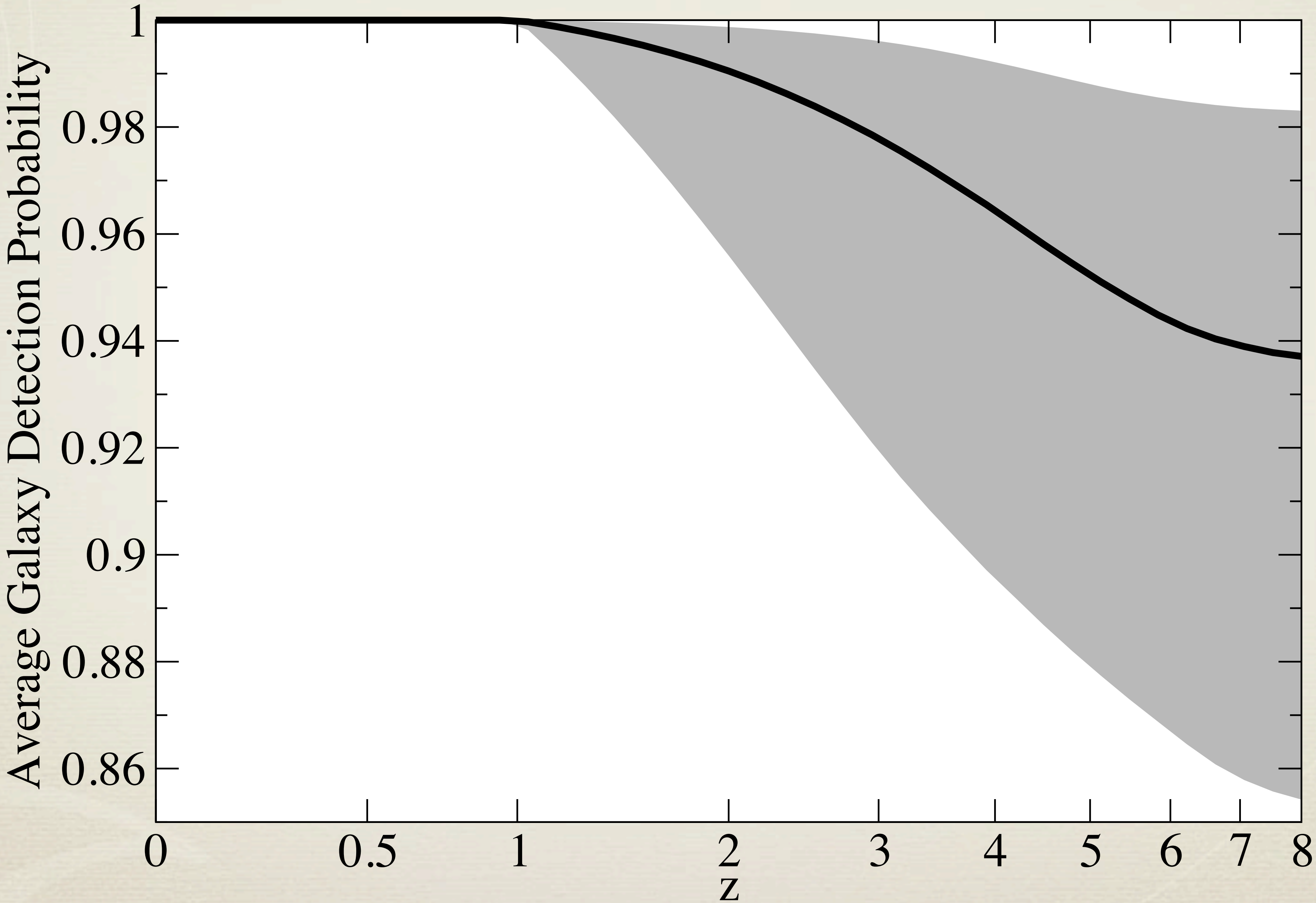
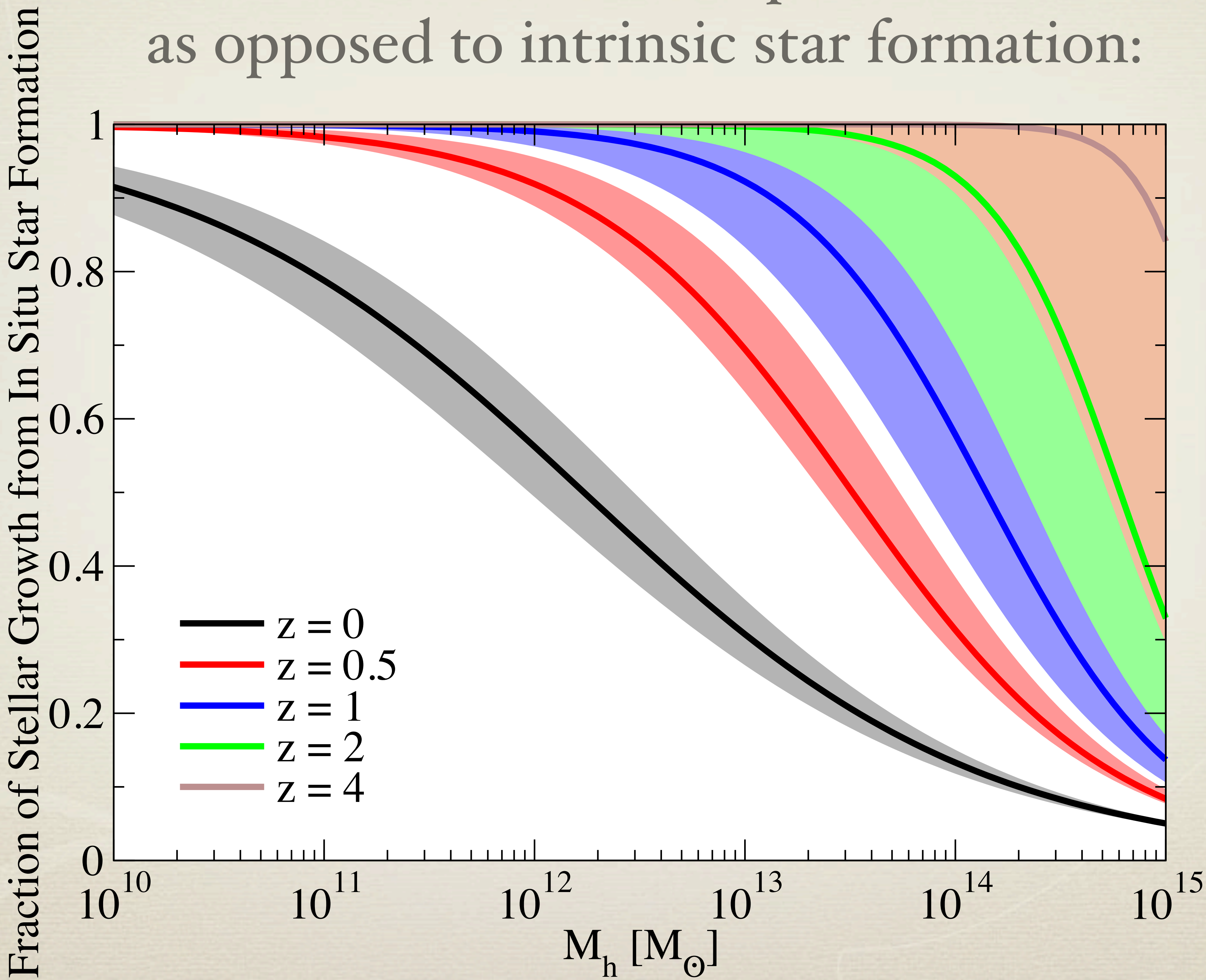
High-Redshift Histories

Suggestions that incompleteness is not an enormous problem:



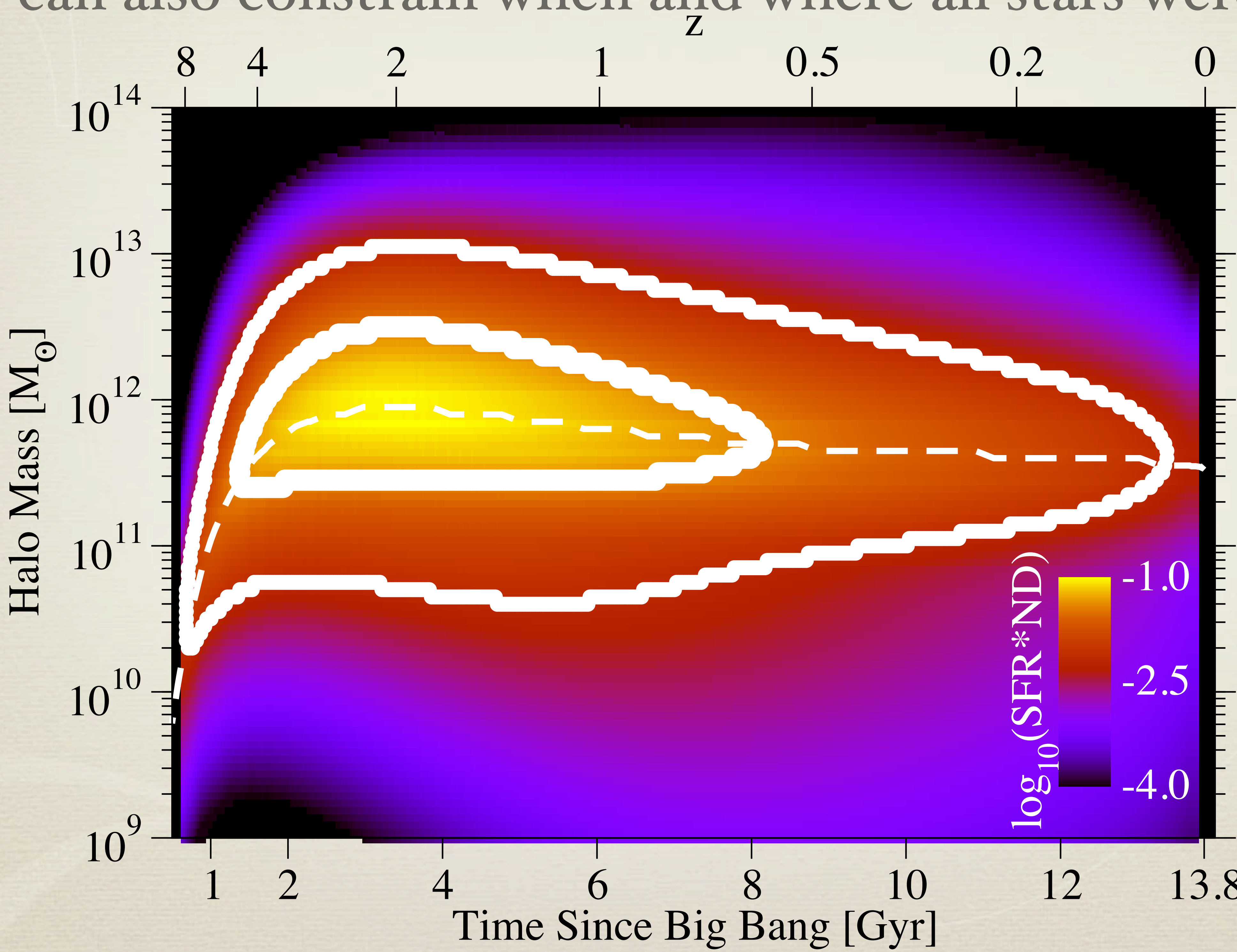
Mergers and the ICL

We can also constrain the buildup of stars from mergers as opposed to intrinsic star formation:



When and Where

We can also constrain when and where all stars were formed:



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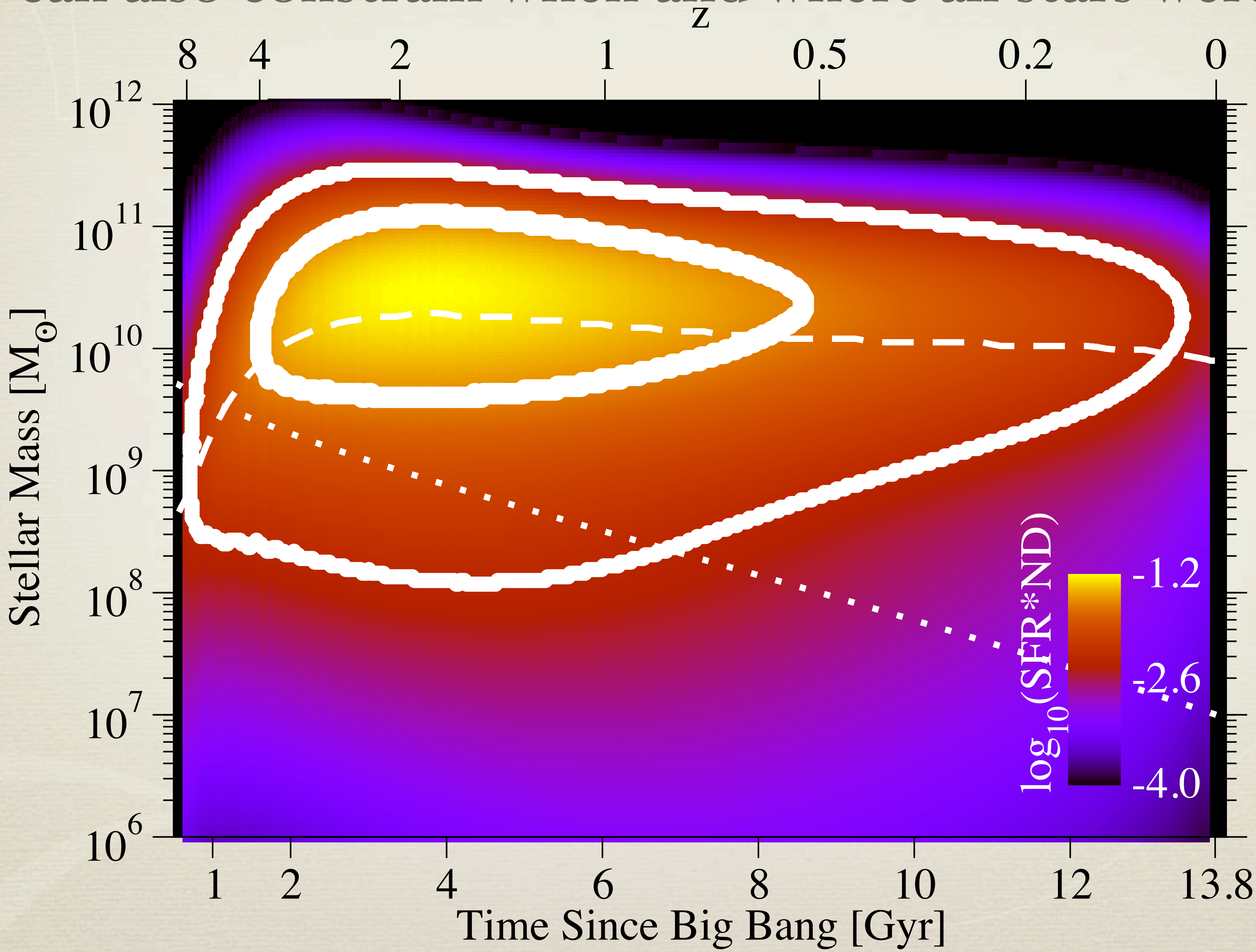

Summary

Most of the stars in the Universe were formed in halos similar in size to the Milky Way.

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Unsurprisingly, this is where the gas to stars conversion efficiency also peaks, at about 20-40% of available hydrogen converted into stars.

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Unsurprisingly, this is where the gas to stars conversion efficiency also peaks, at about 20-40% of available hydrogen converted into stars.

It's more surprising that this efficiency has remained relatively constant over time!

Summary

Galaxies in more massive halos initially formed stars efficiently, but then their star formation rates dropped precipitously after z=2-3 (~10 Gyr ago).

Galaxies in less massive halos have increasing star formation efficiencies, but fairly flat star formation rates at late times.

Summary

High-redshift star formation histories are well-approximated by power laws.

High-redshift incompleteness may be on the order of 0-20%.

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Summary

At high redshifts, most galaxies build up most of their stars through internal star formation.

At late times, massive galaxies switch to mostly merger-driven growth

BUT

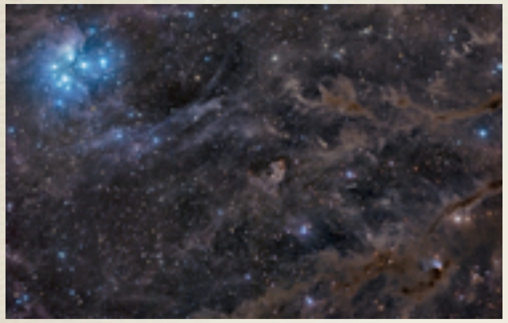
Most mergers in massive halos in fact get disrupted into the ICL, and only a tiny fraction make it to the BCG.

Summary

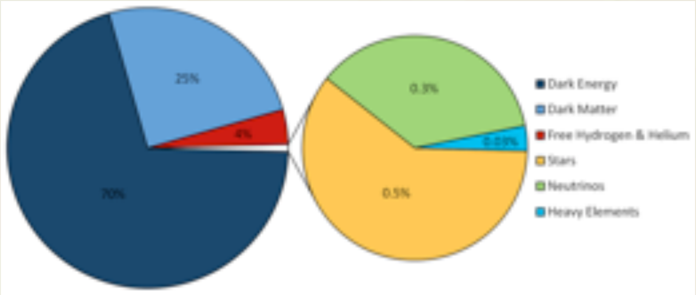
Both merger-driven growth and star formation
are inefficient at late times in massive halos;
it's just that star formation is much *more* inefficient.

Thank you for listening!

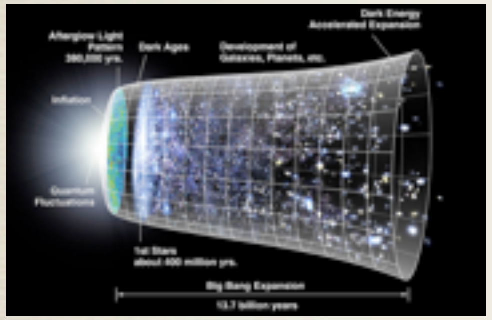
Image Sources



John Davis; http://apod.nasa.gov/apod/ap101118.html

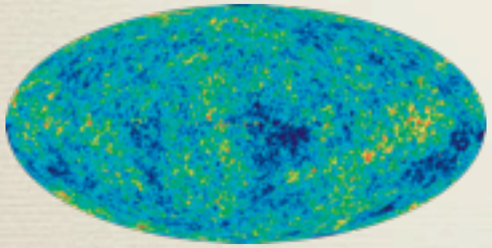


Azcolvin429; http://en.wikipedia.org/wiki/File:Cosmological_Composition_-_Pie_Chart.png



NASA; http://en.wikipedia.org/wiki/File:CMB_Timeline300_no_WMAP.jpg

Jesus Vargas; http://apod.nasa.gov/apod/ap110913.html



NASA; http://en.wikipedia.org/wiki/File:WMAP_2010.png

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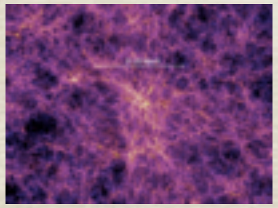
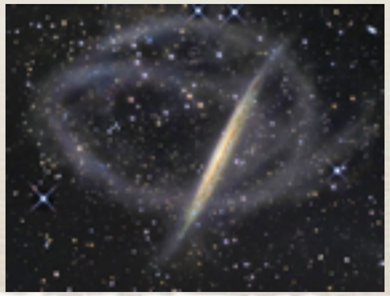


Volker Springel; http://www.mpa-garching.mpg.de/galform/millennium/

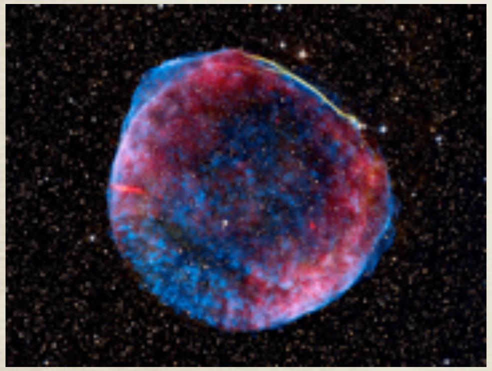


R. Gabany; http://www.nature.com/nature/journal/v477/n7364/full/477286a.html

Image Sources

Adam Block: http://apod.nasa.gov/apod/ap090414.html

HUDF Working Group; http://apod.nasa.gov/apod/ap040309.html



NASA; http://apod.nasa.gov/apod/ap080704.html

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