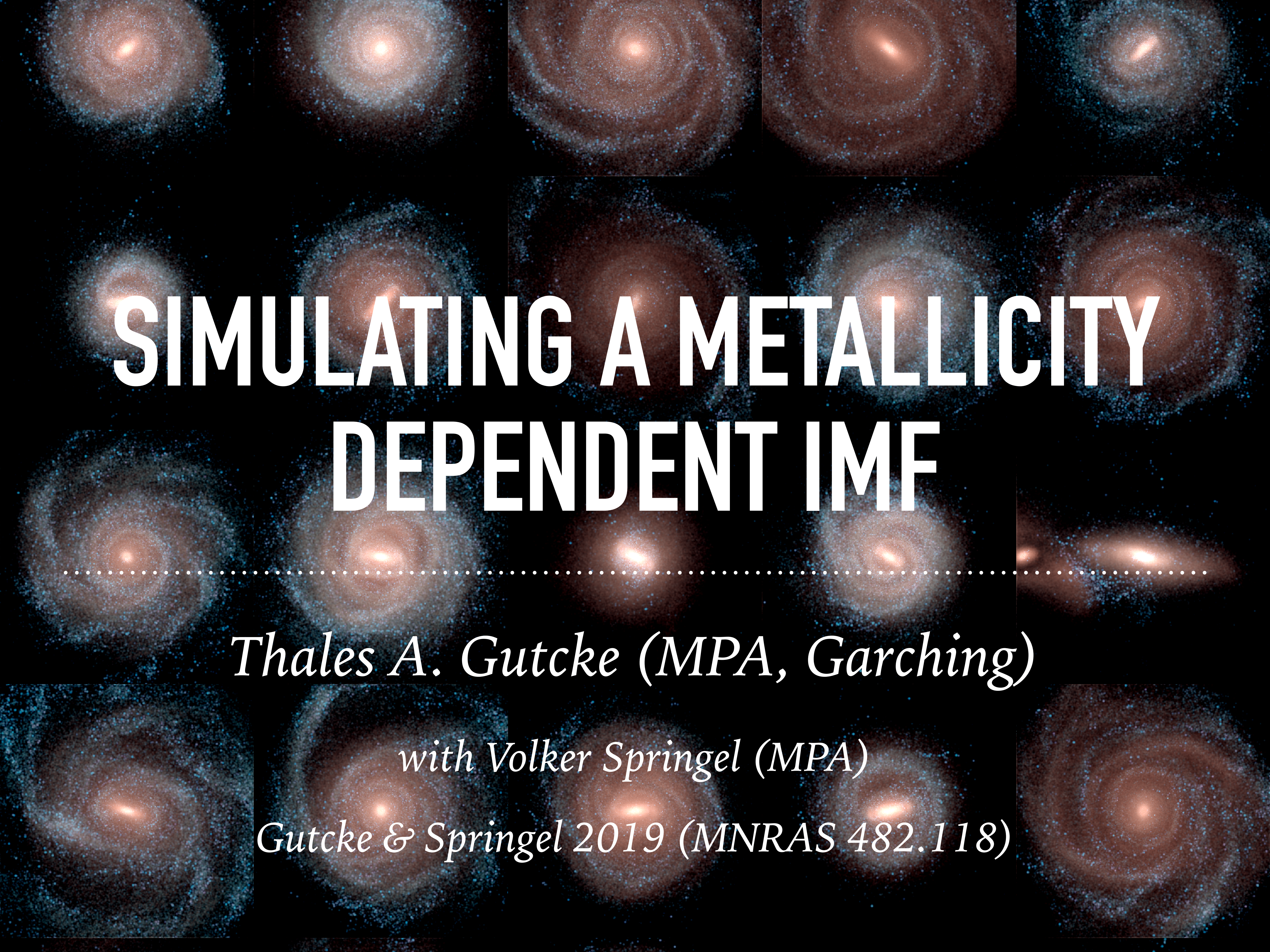


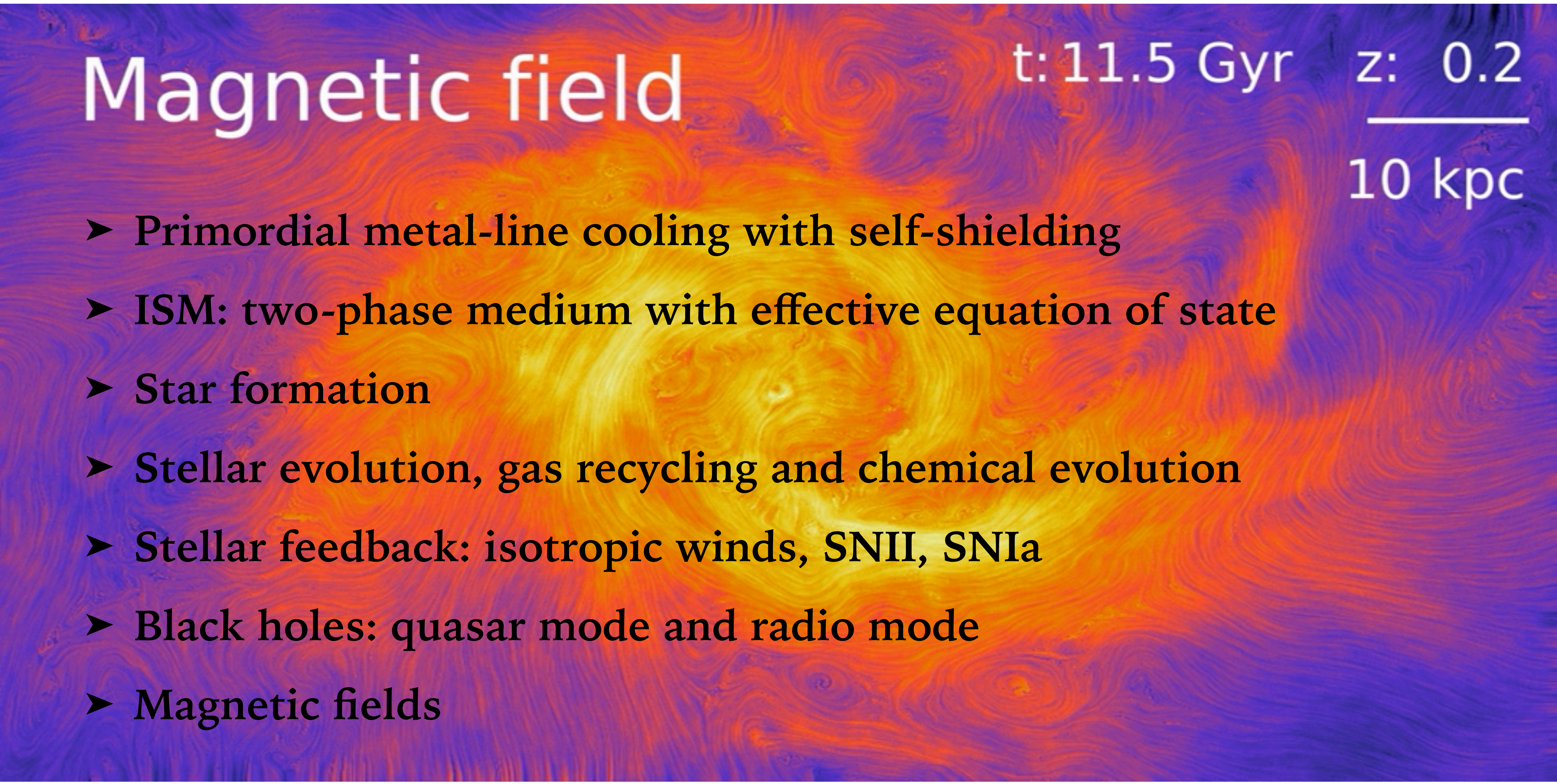
SIMULATING A METALLICITY DEPENDENT IMF

Thales A. Gutcke (MPA, Garching)

with Volker Springel (MPA)

Gutcke & Springel 2019 (MNRAS 482.118)

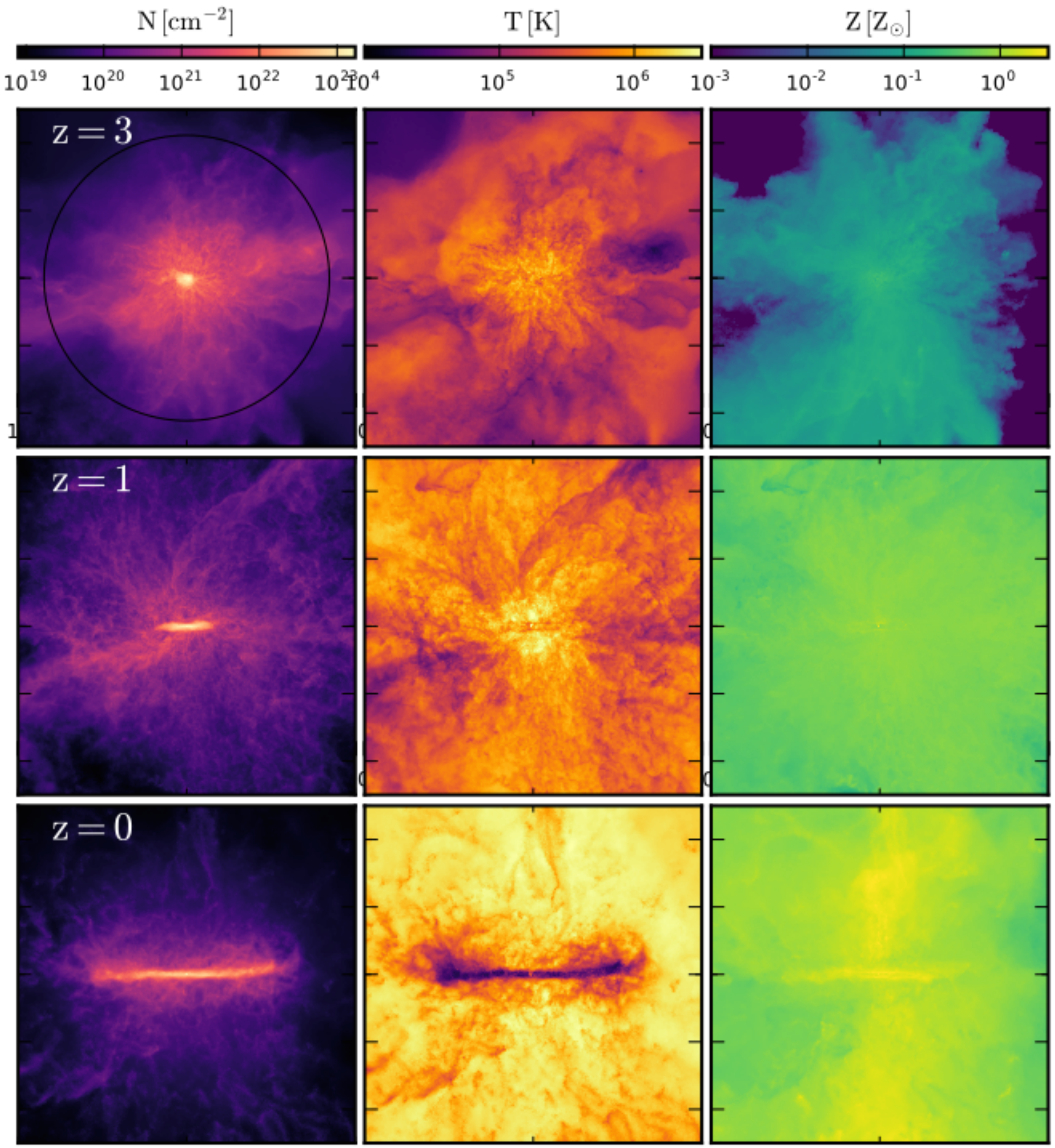
SIMULATIONS: AURIGA – MILKY WAY MASS GALAXIES



- Primordial metal-line cooling with self-shielding
- ISM: two-phase medium with effective equation of state
- Star formation
- Stellar evolution, gas recycling and chemical evolution
- Stellar feedback: isotropic winds, SNII, SNIa
- Black holes: quasar mode and radio mode
- Magnetic fields

Grand et al. 2017

SIMULATIONS: AURIGA – MILKY WAY MASS GALAXIES

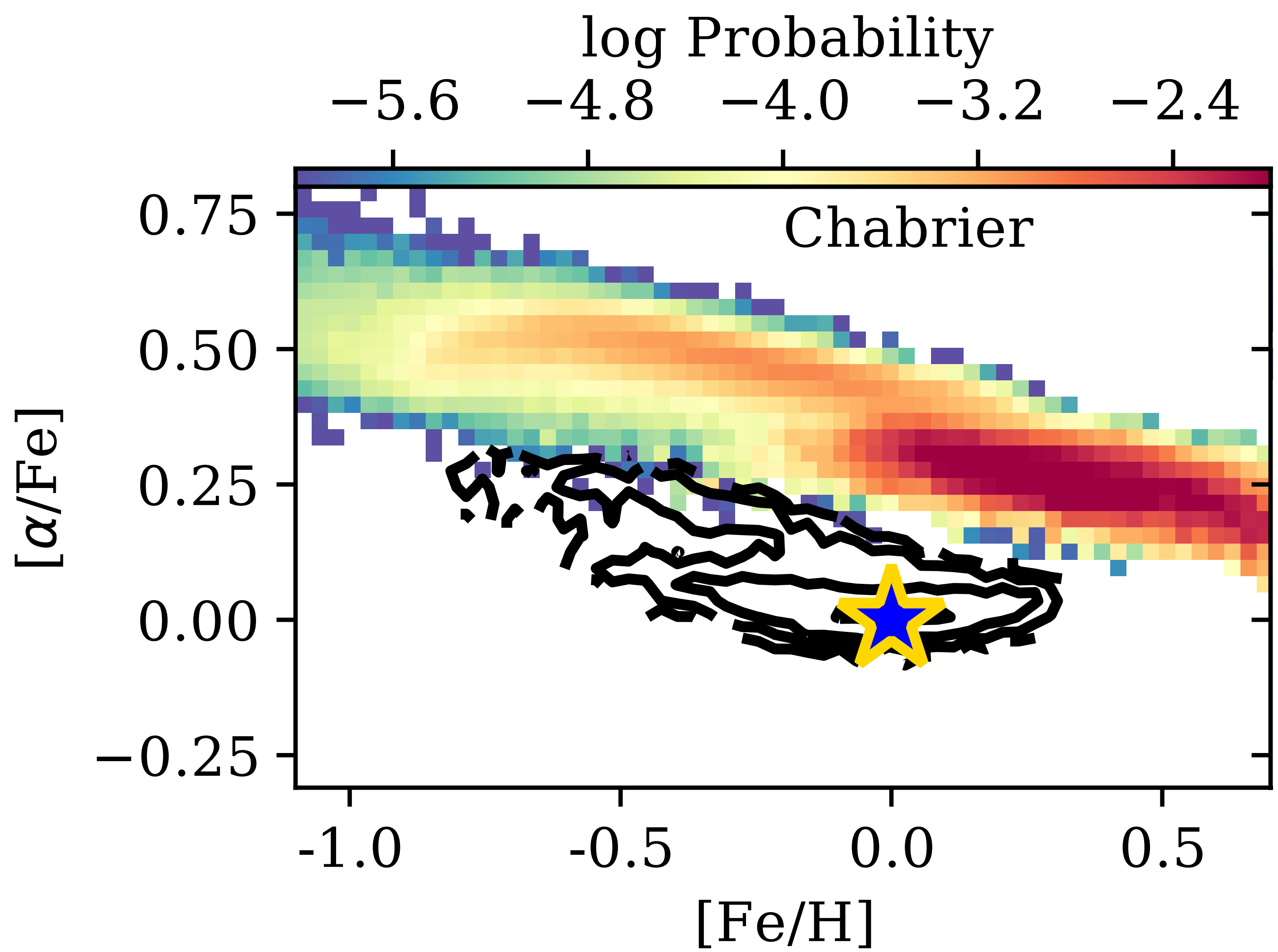


Reproduce a wide range of present-day observables:

- two component disc dominated galaxies
- stellar masses
- sizes
- rotation curves
- star formation rates
- metallicities

Grand et al. 2017

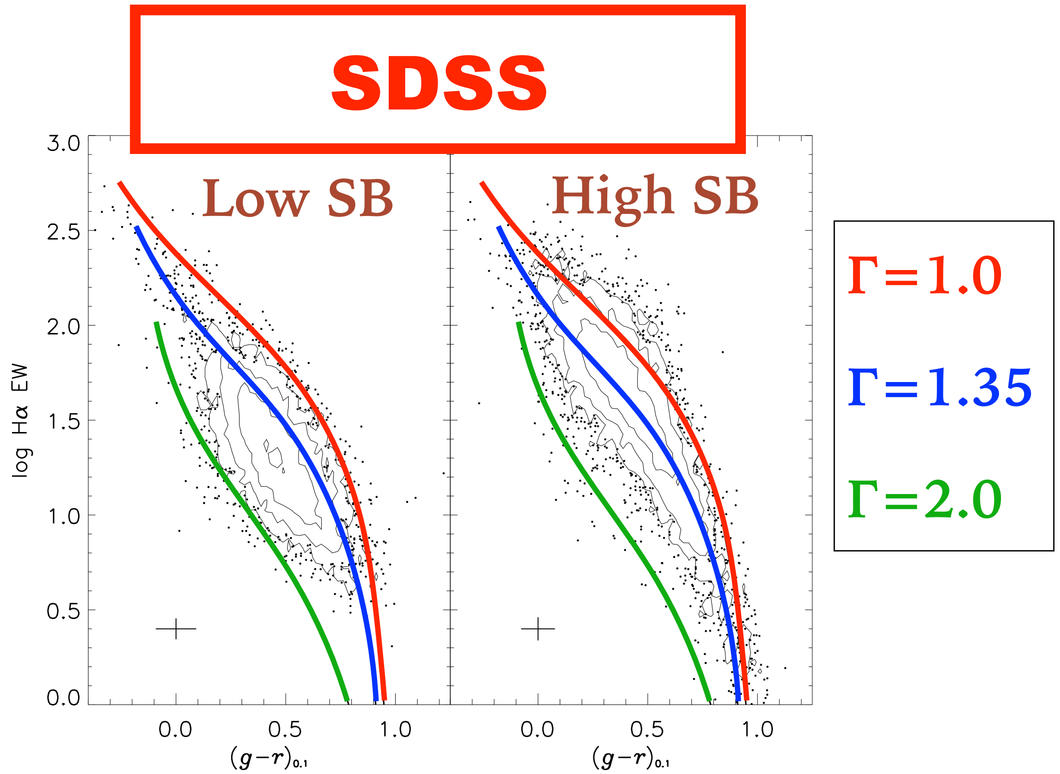
PROBLEM IN ALPHA ABUNDANCES



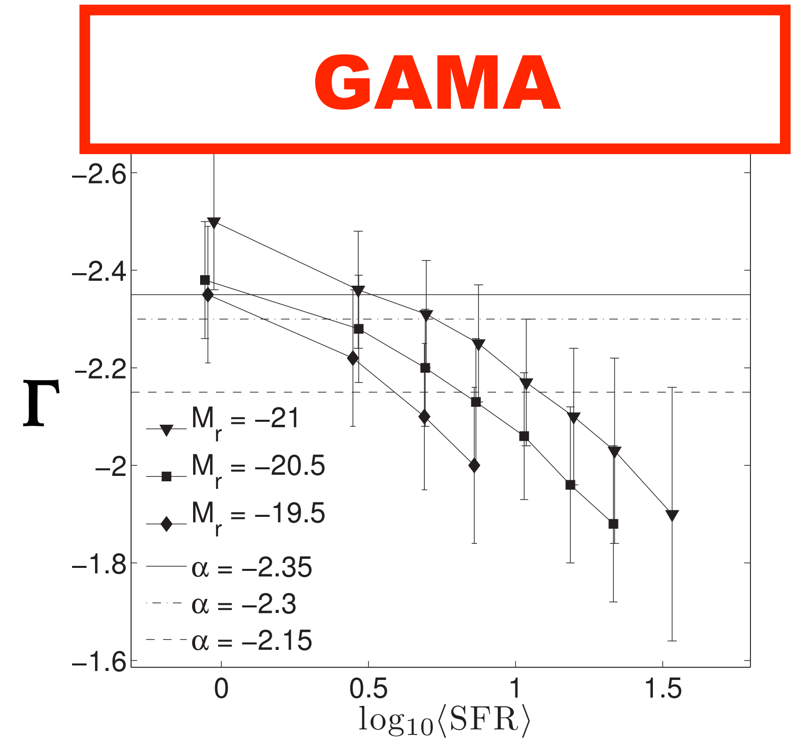
Black contours: APOGEE survey data, applied selection function

Gutcke & Springel 2019

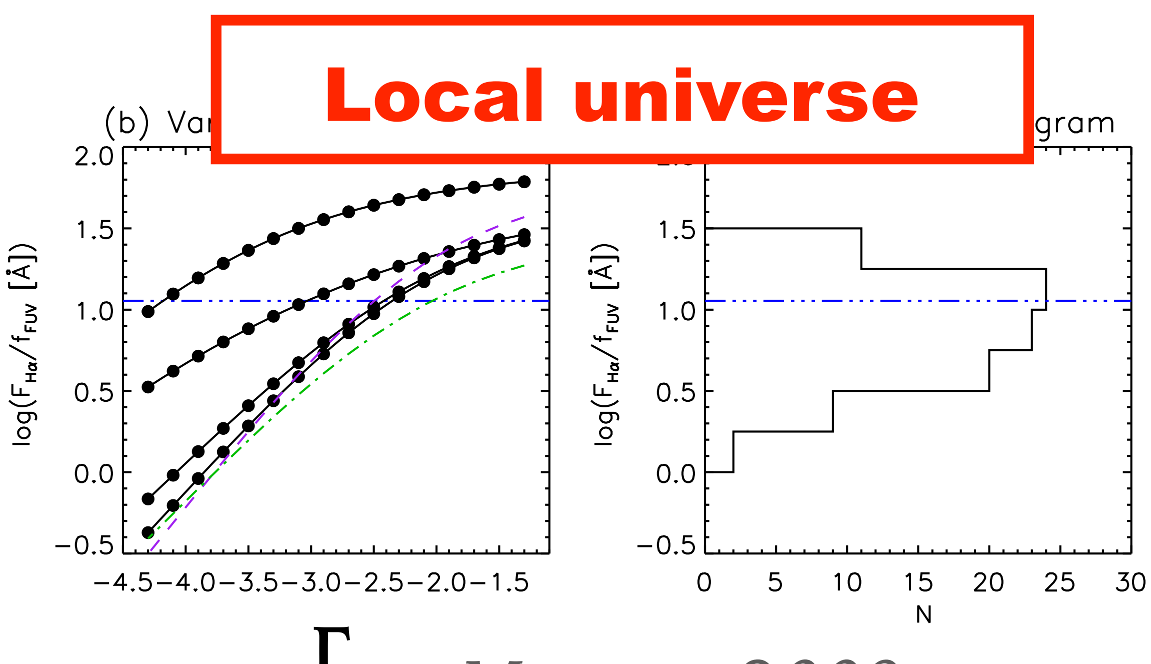
OBSERVED IMF VARIATIONS (NON-EXHAUSTIVE)



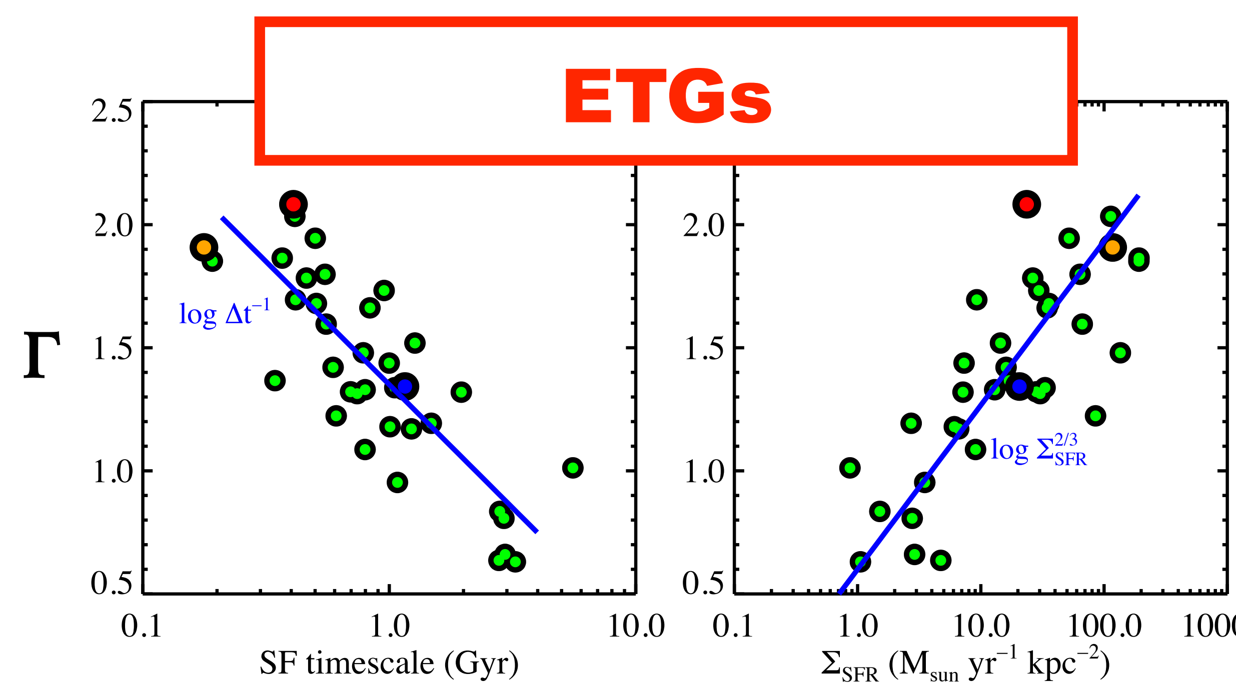
Hoversten & Glazebrook 2008



Gunawardhana+2011

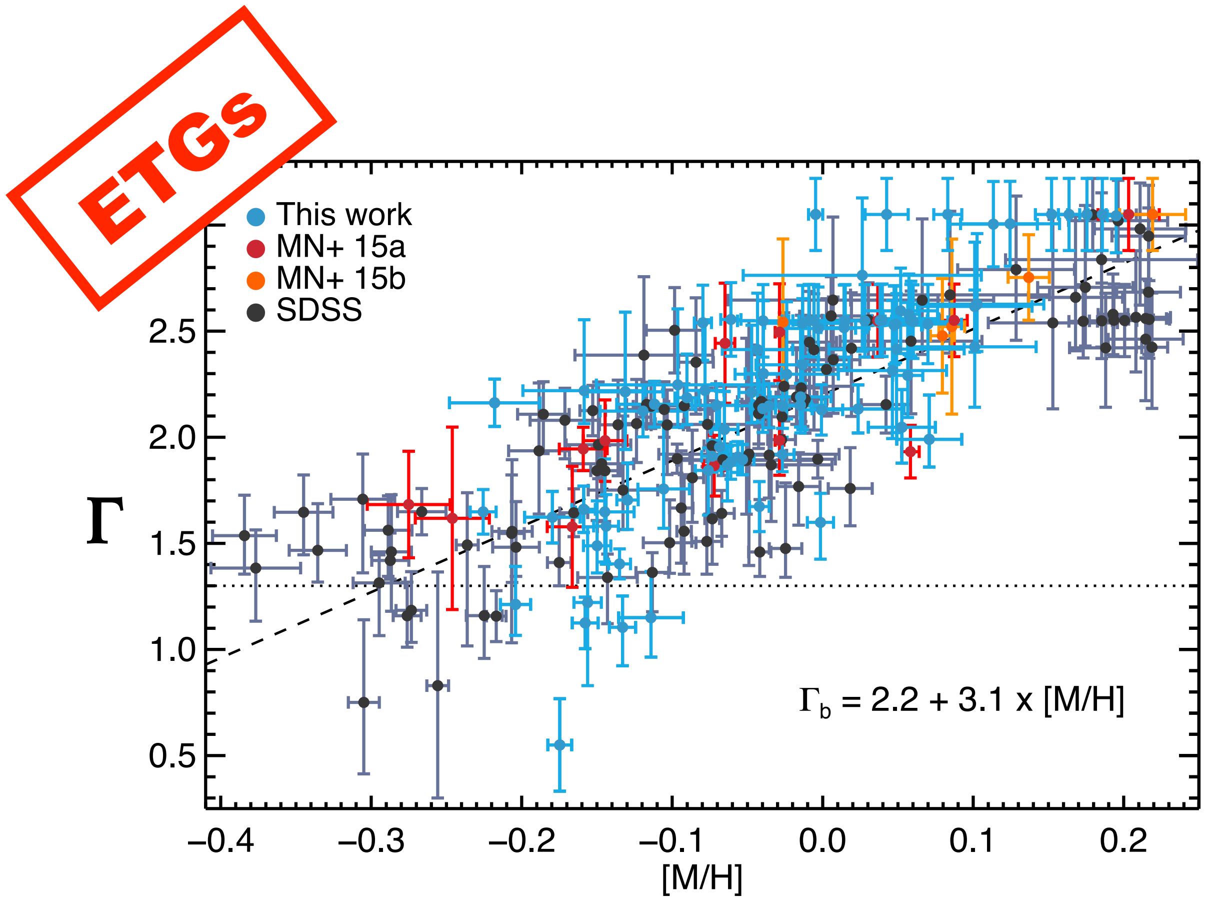


Meurer+2009



Conroy & van Dokkum 2012

METALLICITY DEPENDENCY



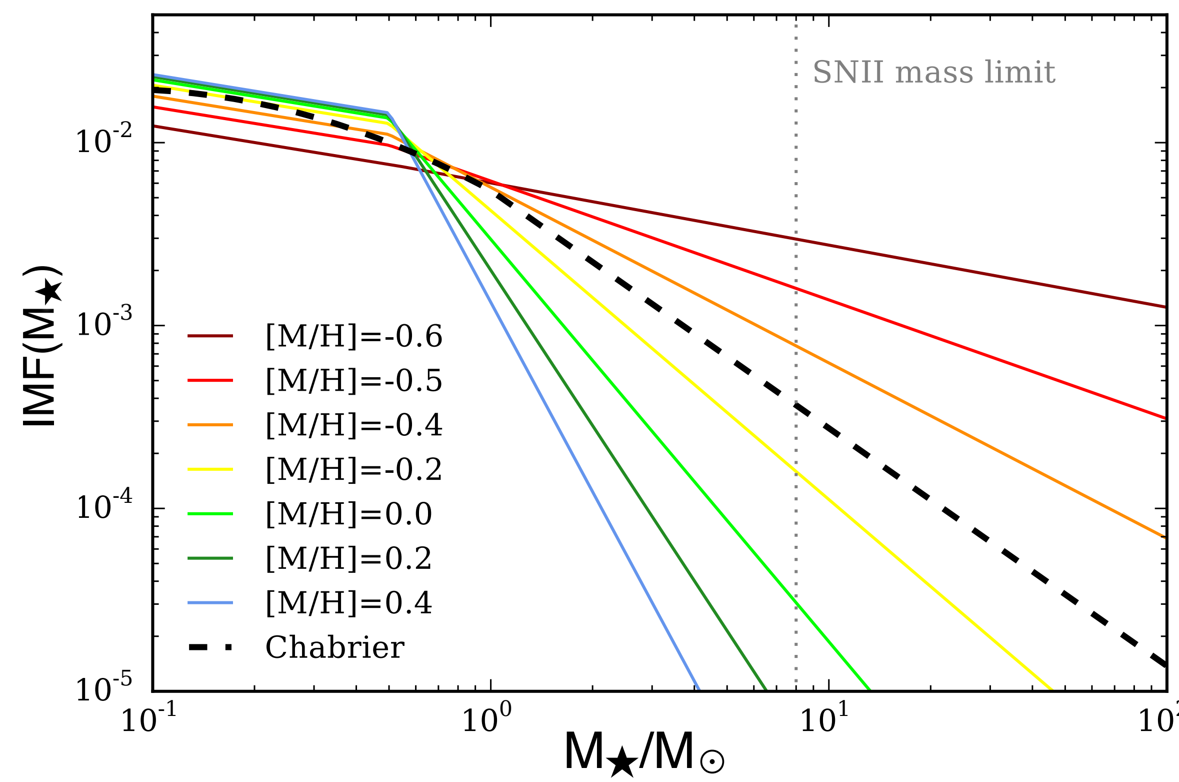
Martin-Navarro+2015

Star particle as an entire single stellar population

At each timestep integrate IMF to calculate SN rate

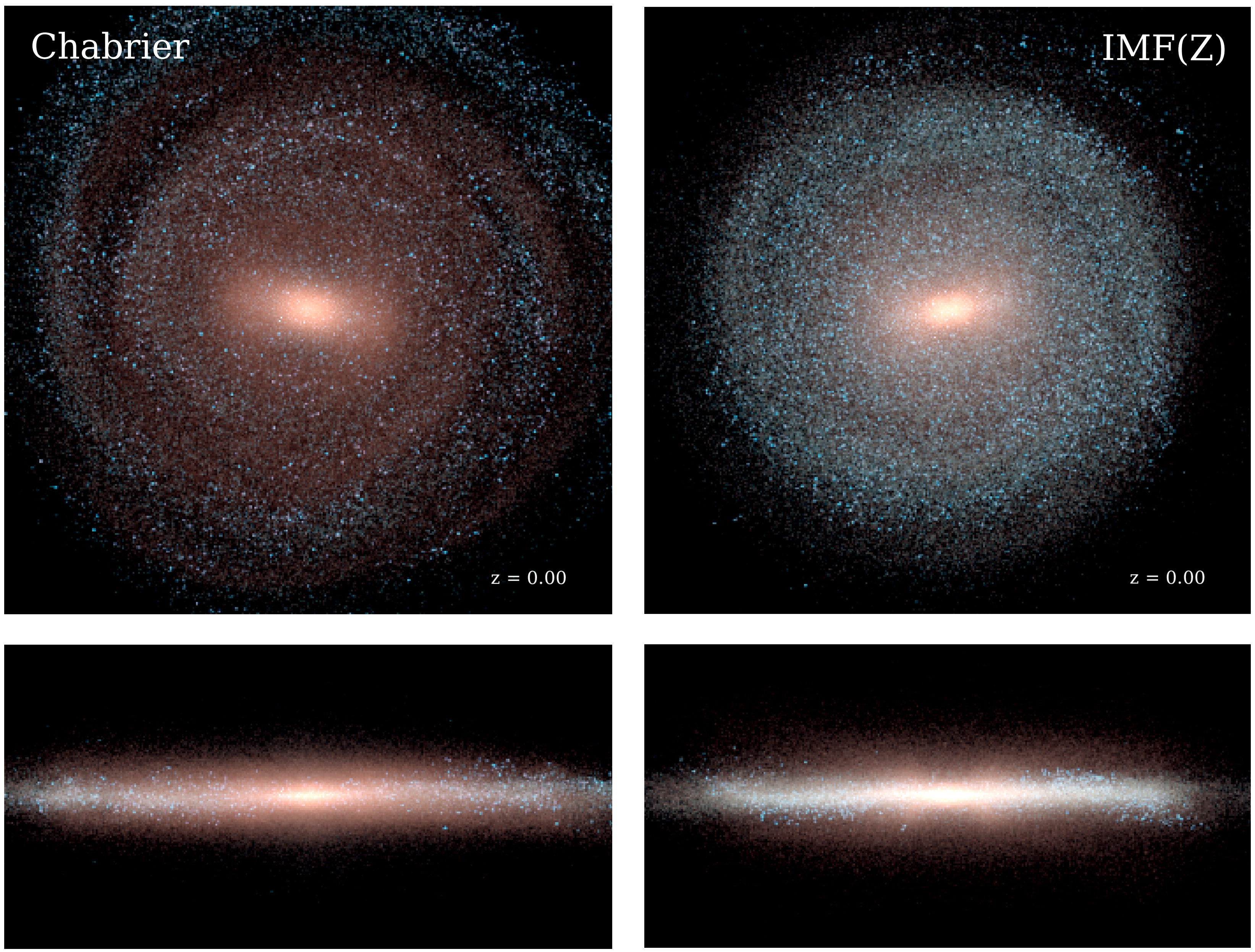
“Zoom-in” galaxy simulations

$M_\star \sim 5 \cdot 10^4 \, M_\odot$



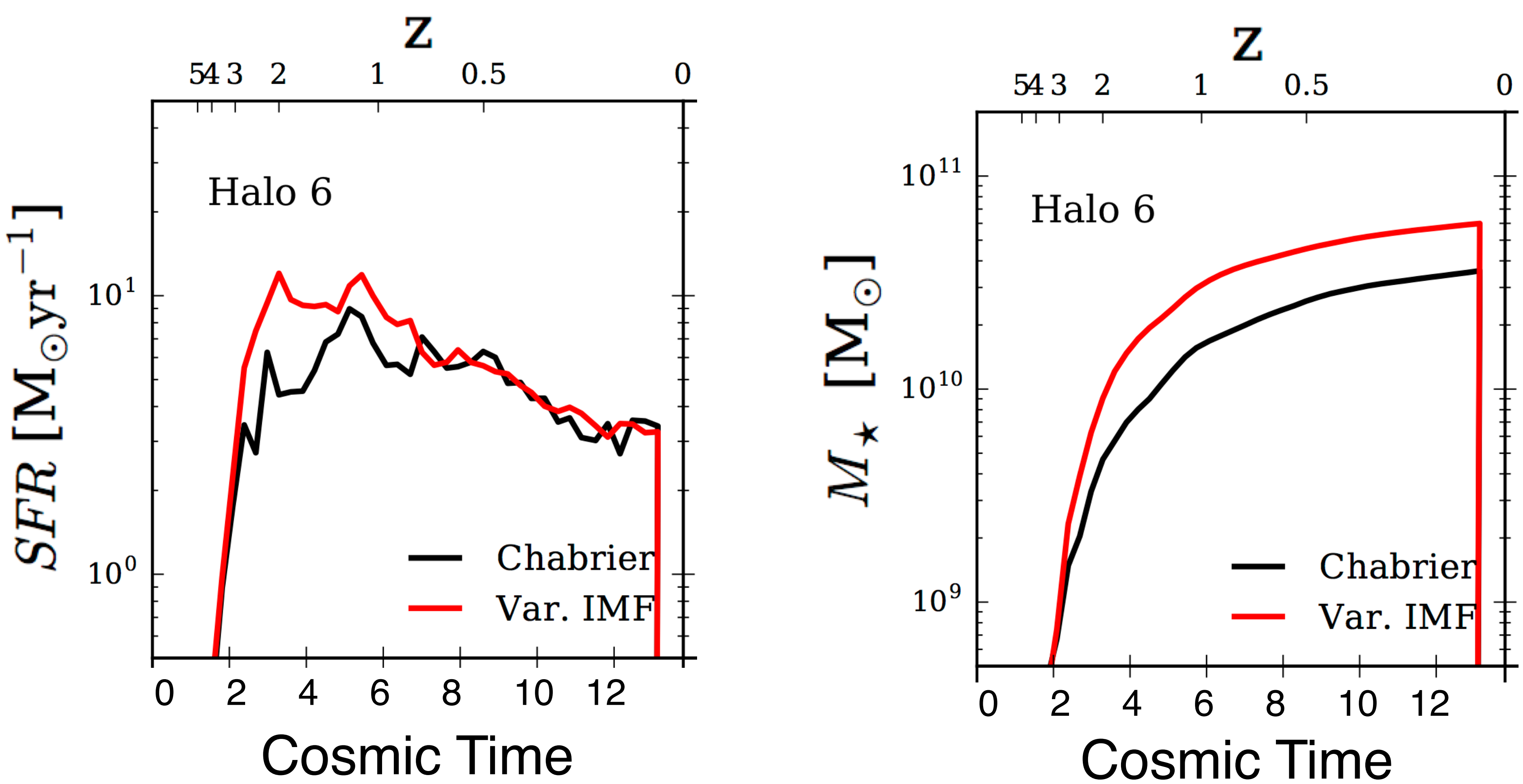
Gutcke & Springel 2019

MOCK STELLAR LIGHT



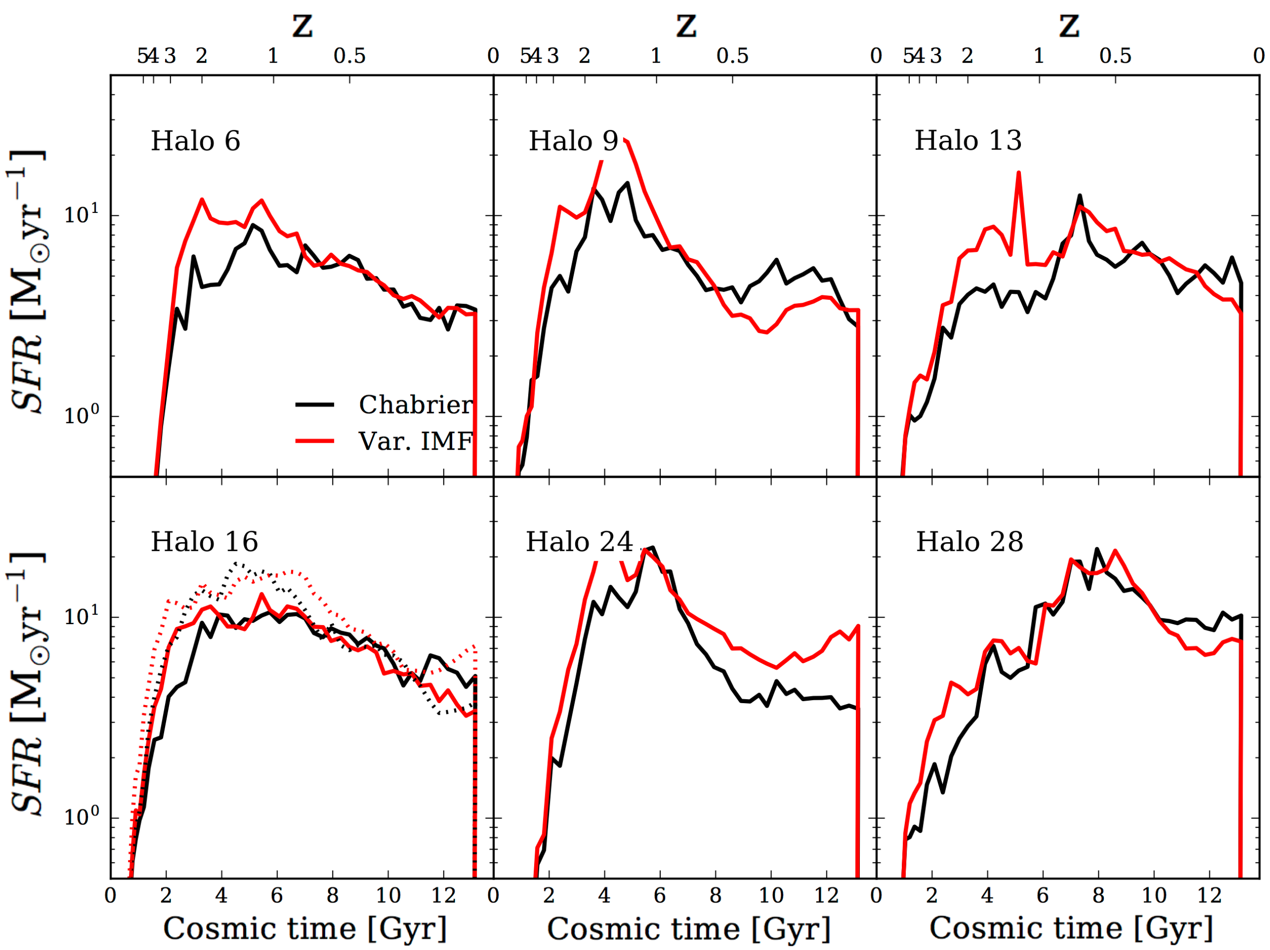
Gutcke & Springel 2019

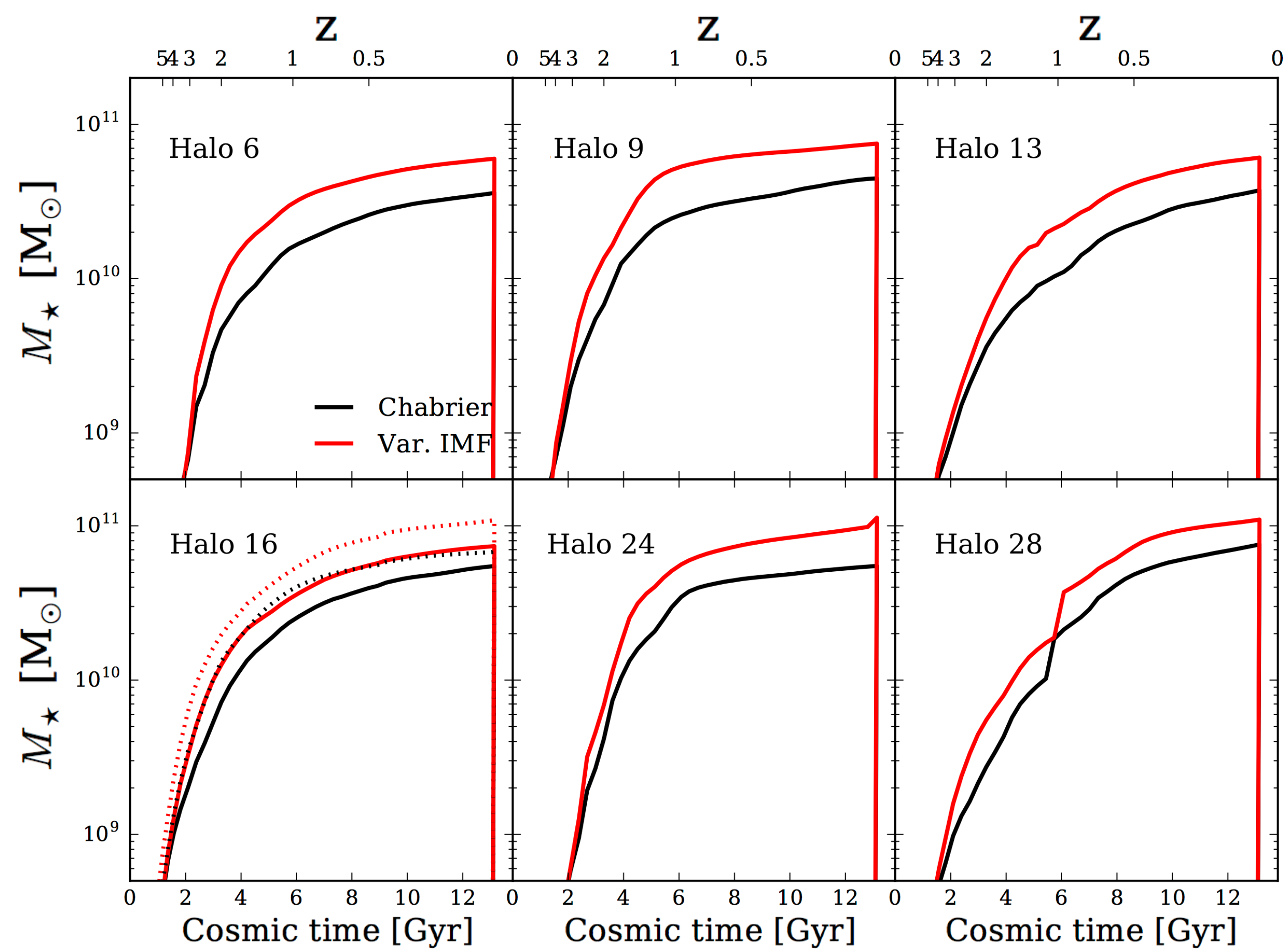
SFH AND TOTAL STELLAR MASS



Gutcke & Springel 2019

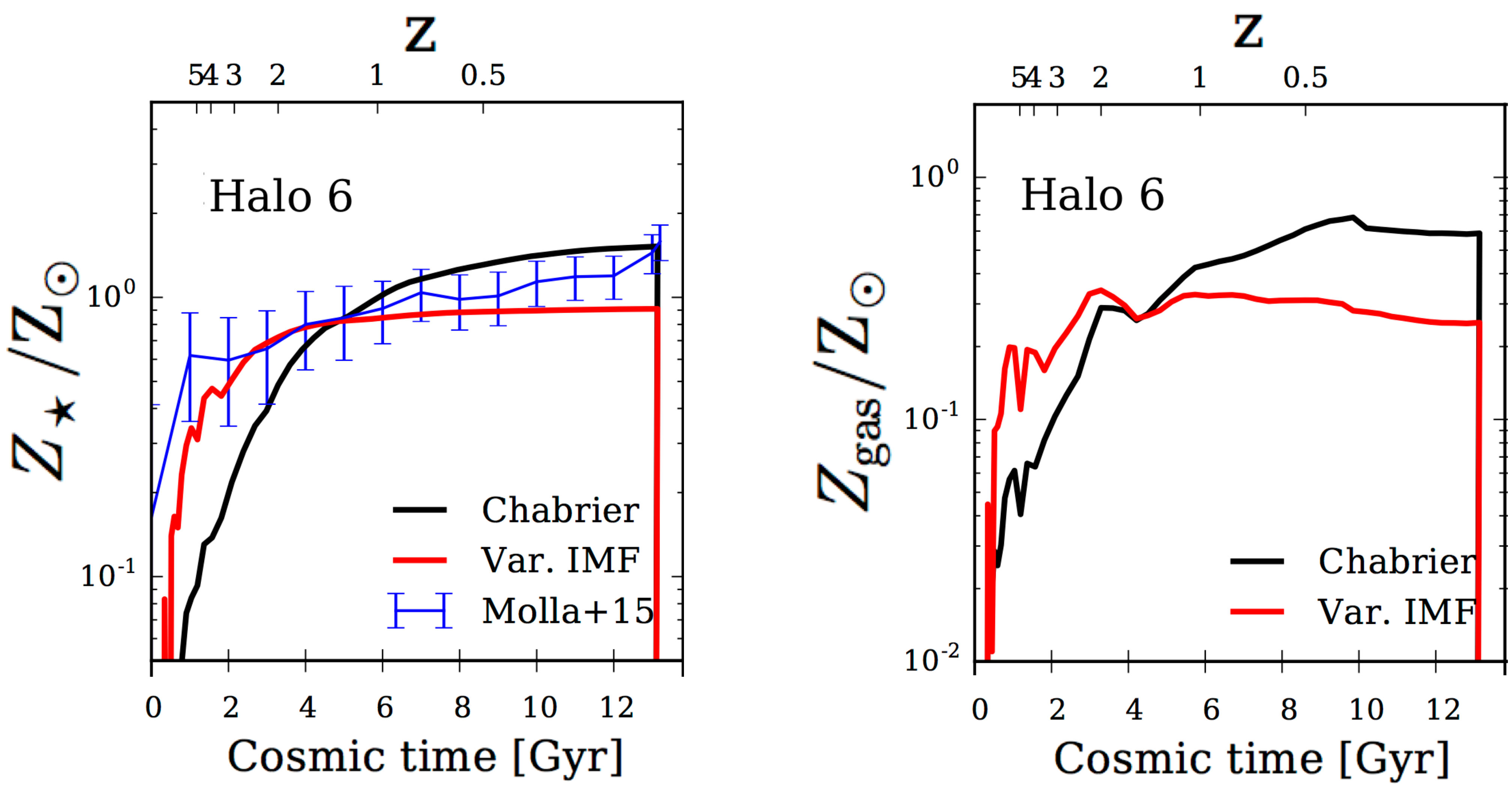
SFH AND TOTAL STELLAR MASS





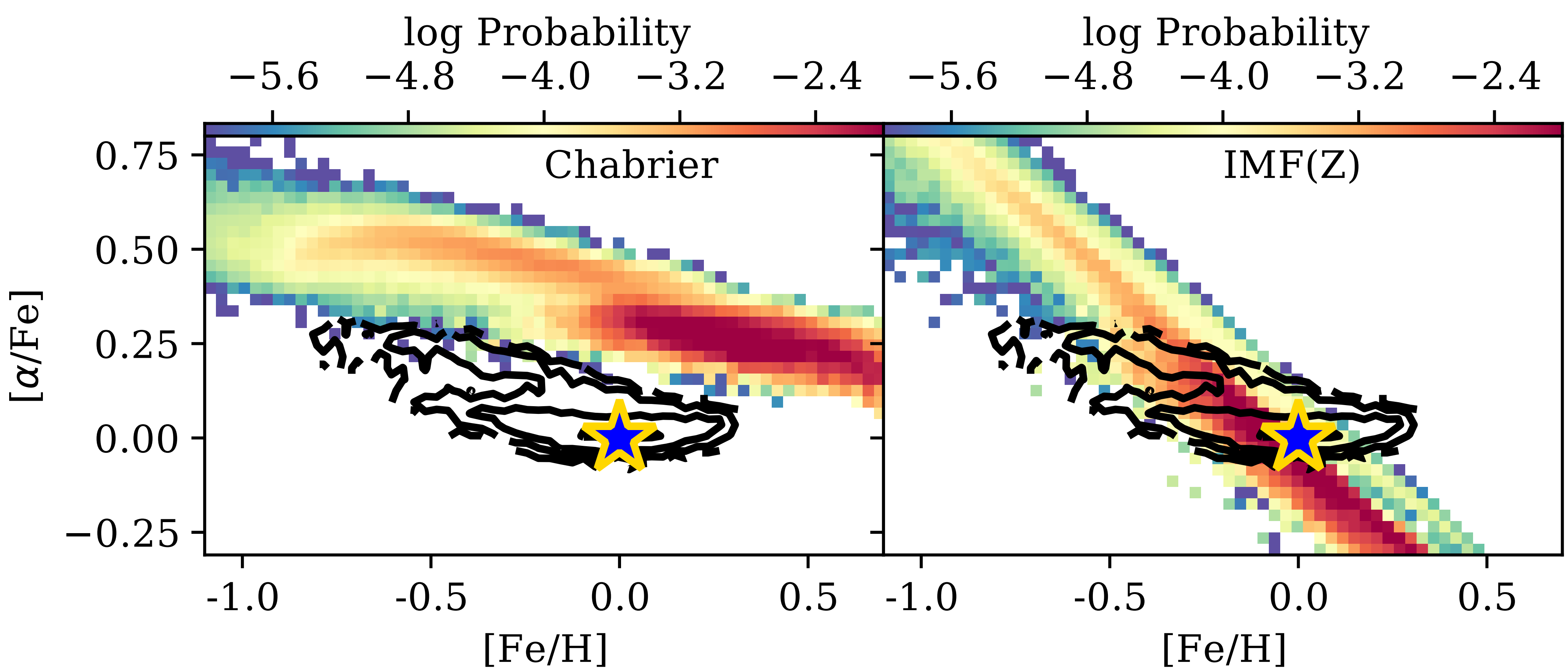
Gutcke & Springel 2019

METALLICITY EVOLUTION



Gutcke & Springel 2019

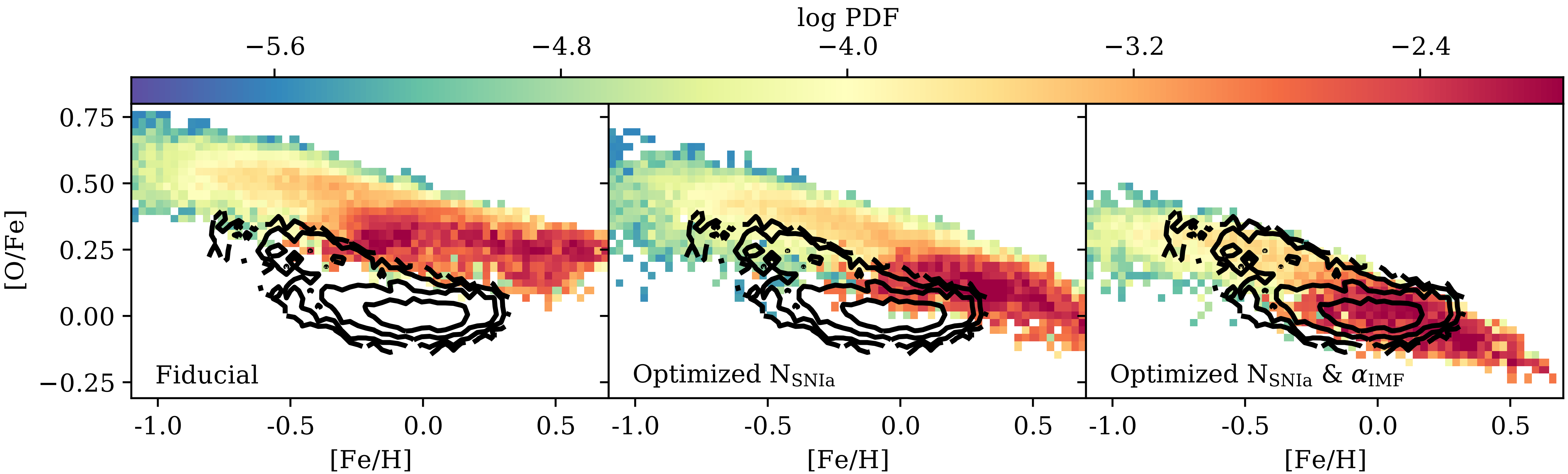
ALPHA ABUNDANCES



Black contours: APOGEE survey data, applied selection function

Gutcke & Springel 2019

OPTIMISED IMF PARAMETERS



Optimized with chemical evolution model (chempy)

$\Gamma_{bestfit} = -2.45 \pm 0.15$

$N_{Ia} = 1.29 \pm 0.45 \times 10^{-3}\ M_{\odot}^{-1}$

Philcox, Rybizki & Gutcke 2018 (ApJ 861.40)

CONCLUSIONS

- limited impact on morphology and SFHs
- constraints on stellar-to-halo mass ratios, feedback strength, metallicity evolution, and metallicity distributions are degenerate with a metallicity-dependent IMF
- does not aid in the quenching process
- produces up to a factor of 2–3 more stellar mass
- enrichment history and the z=0 MDF significantly affected
- iron abundance in better agreement with observations