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
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)

**SDSS**

Low SB

High SB

\[ \Gamma = 1.0 \]

\[ \Gamma = 1.35 \]

\[ \Gamma = 2.0 \]

Hoversten & Glazebrook 2008

**GAMA**

\[ \Gamma \]

Gunawardhana+2011

**Local universe**

Meurer+2009

**ETGs**

Conroy & van Dokkum 2012
METALLICITY DEPENDENCY

“Zoom-in” galaxy simulations

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

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Star particle as an entire single stellar population

At each timestep integrate IMF to calculate SN rate

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**Martin-Navarro + 2015**

**Gutcke & Springel 2019**
MOCK STELLAR LIGHT

Chabrier

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
Optimized with chemical evolution model (chempy)

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

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

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