1500 AMERICAN MUSEUM b NATURAL HISTORY

ERIC ANDERSSON STAR-BY-STAR SIMULATIONS OF DWARF GALAXIES IN COSMOLOGICAL ENVIRONMENTS



HYDRODYNAMICAL SIMULATIONS OF GALAXIES

- Galaxy evolution extreme dynamical range
- Star-by-star models bridging the gap between small and large scales

Wall et al. (2019,2020), see also Polak et al. (inc. EA, submitted)





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Andersson et al. (2021,2022,2023)

Agertz et al. (2021, inc. EA),





STAR-BY-STAR MODELS

see, e.g., Emerick et al (2018), Andersson et al. (2020), Lahen et al. (2020), Hiriai et al. (2021), Gutcke et al. (2021), Hislop et al. (2022), Steinwandel et al. (2022), Calura et al. (2022)

INFERNO

see Andersson et al. (2020,2021,2023)

- Implemented in RAMSES hydrodynamics code Teyssier (2002)
- Individual stars sampled from IMF
- ▶ Natal kicks to simulate unresolved stellar dynamics, e.g., walkaway & runaway stars
- Feedback (winds + SNe) linked to stellar evolution phases
- Chemical enrichment based on yield tables













ENGINEERING DWARFS AT GALAXY FORMATION'S EDGE (EDGE)

see Agertz et al. (2020), Rey et al. (2019,2020,2022,2023), Pontzen et al. (2021), Orkney et al. (2021,2022,2023), Prgomet et al. (2022), Goater et al. (2024)

- Simulating the smallest galaxies
- Reionization relics probes of the early Universe
- Halos with similar redshift zero mass but different histories Genetic modification technique with genetIC, Stopyra et al. (2021)
- lndividual stars for $m_{\star} > 0.5 \,\mathrm{M}_{\odot}$







4

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- On the ultra-faint dwarf galaxy limit
- Spatial properties marginally resolved without star-by-star — problematic for fainter galaxies









TRACING CHEMICAL ENRICHMENT IN THE SMALLEST GALAXIES

- SNe la yields from Seitenzahl et al. (2013)
- ▶ Most [X/Fe] are low, except [C/Fe].



Chemical enrichment by interpolating yield tables (NuGrid, Pignatari et al., 2016; Ritter et al., 2018)





TRACING CHEMICAL ENRICHMENT IN THE SMALLEST GALAXIES

Preliminary results (z=6) from additional yields tables (Limongi & Chieffi, 2018)





THE CHALLENGE OF OBSERVING THE SMALLEST GALAXIES

- Member detection from spectroscopy (velocity) see review by Simon (2019)
- Magnitude limitation: ~19 mag for high resolution



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THE CHALLENGE OF OBSERVING THE SMALLEST GALAXIES

- Abundance estimation limited to nearby dwarfs
- Shot noise from low giant branch occurrence rate





THE CHALLENGE OF OBSERVING THE SMALLEST GALAXIES

- What scatter is introduced by giant branch shot noise?
- \blacktriangleright Resampling IMF in small bins (0.2 $\rm M_{\odot}$) around each star









Stars Dark matter

