Nursing the Milky Way

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--- First stars and first galaxies --- Austin, 10 March 2010 ---

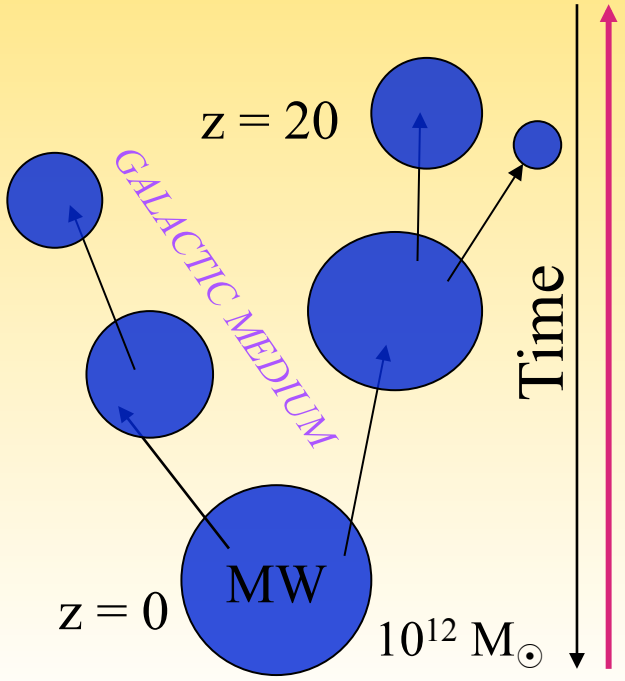
GAlaxyMErgerTree&Evolution

GAMETE

Salvadori, Schneider & Ferrara 2007

Solving the evolution of M_g, M_*, M_Z, M_{Fe}, M_O along the hierarchical tree

- Stars form in *Lyα*-cooling haloes $T_{vir} > 10^4 K \rightarrow M_{sf}(z) > M_4(z)$
- Reionization photoheating (Gnedin00, Kitayama+00) $\rightarrow M_{sf}(z) > M_{30}(z)$ *for* $z < z_{rei}=6$
- SFR = $f_* M_g/t_{ff}$
  - $Z < Z_{cr}=10^{-5\pm1} Z_\odot$ PopIII stars (Bromm+01;Omukai+05; Schneider+02)
  - $Z > Z_{cr}$ PopII/I stars
- Mechanical feedback $\dot{M}_{ej} \propto f_{ej} \dot{N}_{sn} / v^2_{esc}$
  perfect mixing approximation
- DSph satellites are selected among haloes
  $M_{sf} < M < M_{2\sigma}$ (Diemand+05, Madau+06)

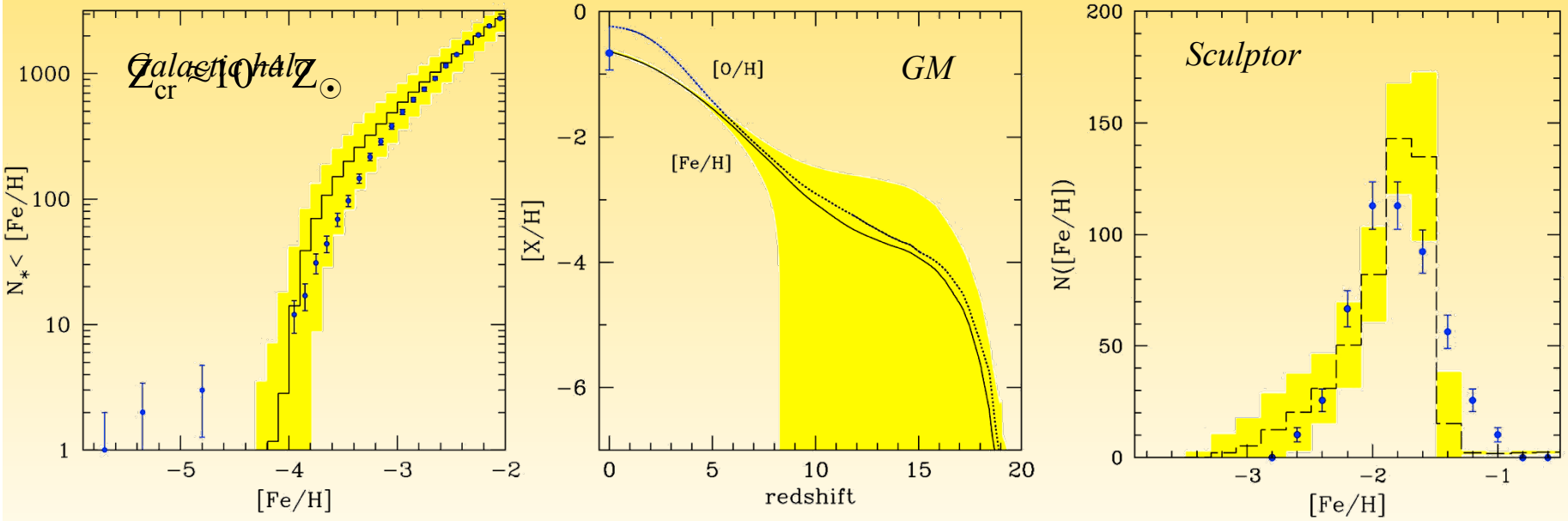


Battaglia+05

A cosmological scenario

Salvadori, Ferrara & Schneider 2008

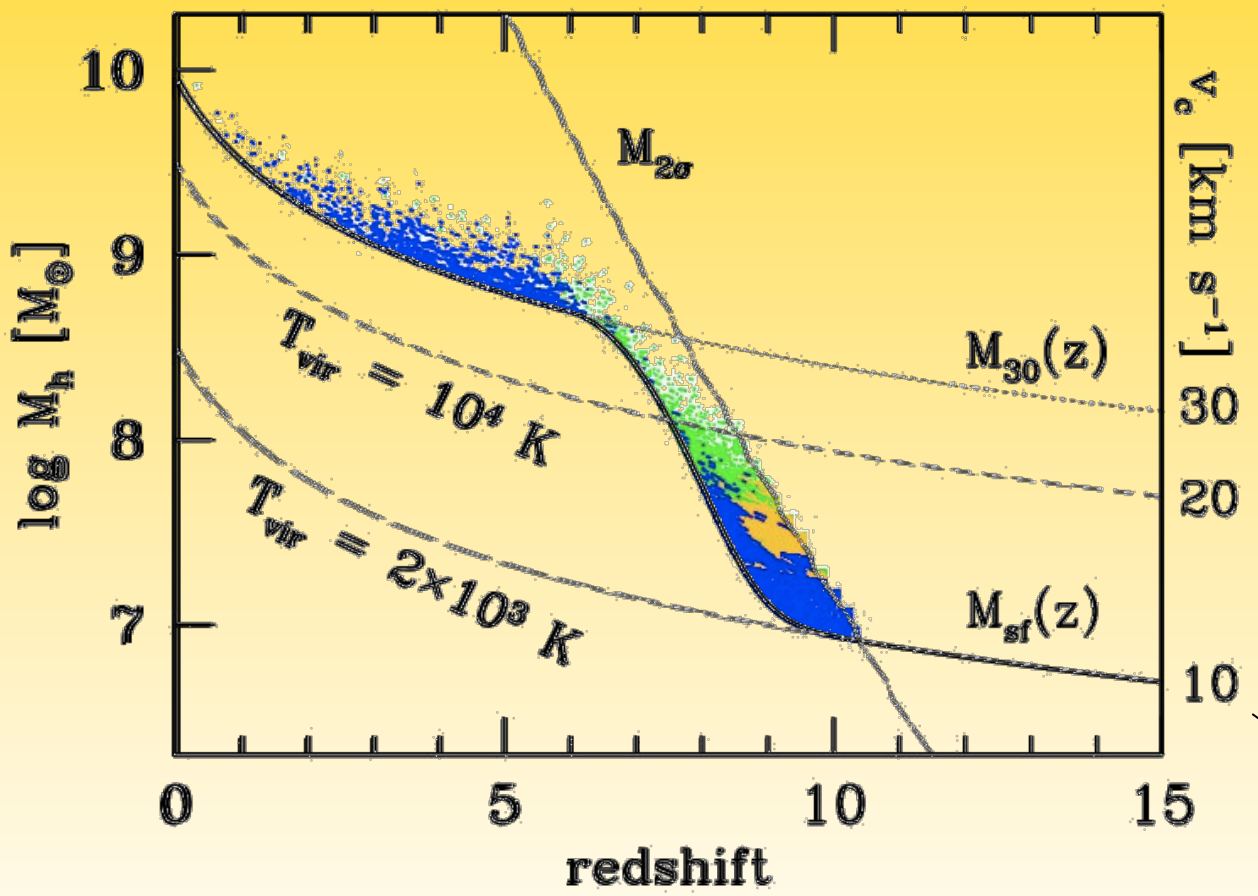
- ✓ Global MW properties (stellar/gas mass & metallicity)
- ✓ Galactic halo Metallicity Distribution Function
- ✓ Main properties of the prototypical Sculptor dSph



DSph satellites with $L_{tot} < 10^5 L_\odot$ are not produced by the model

Including minihaloes

Salvadori & Ferrara 2009



$f_c = (\Omega_b/\Omega_{DM})\, M_g$

$f_b/f_c > 0.5$

Kitayama+00

$0.1 < f_b/f_c < 0.5$

$f_b/f_c < 0.1$

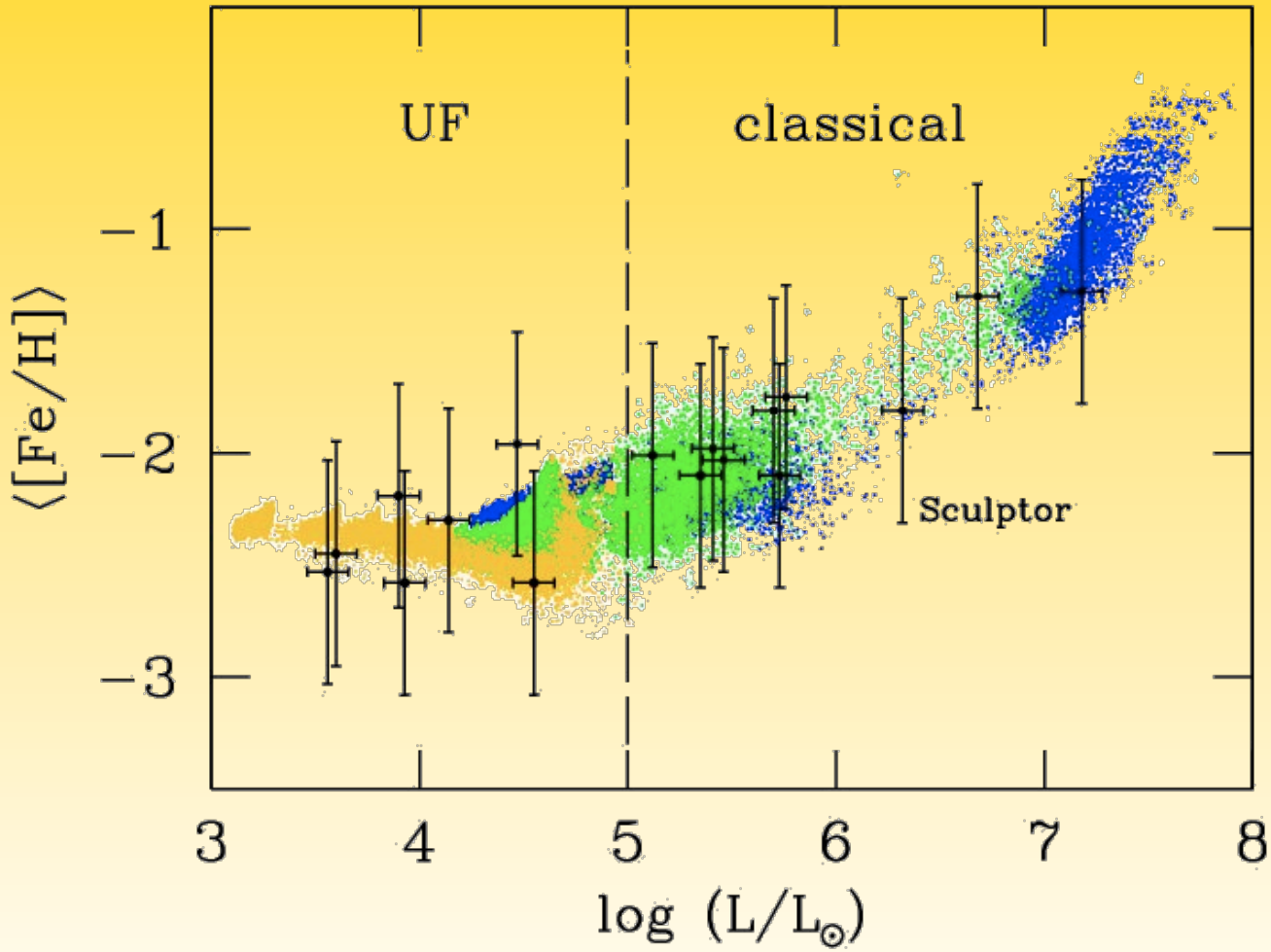
Dijkstra+04

$f_*^{H2} \propto f_* \, (T_{vir}/10^4\,K)^3$

Madau, Ferrara & Rees 01; Ricotti & Gnedin 01; Okamoto+08

The simulated Fe-L relation

Salvadori & Ferrara 2009



$f_b/f_c > 0.5$

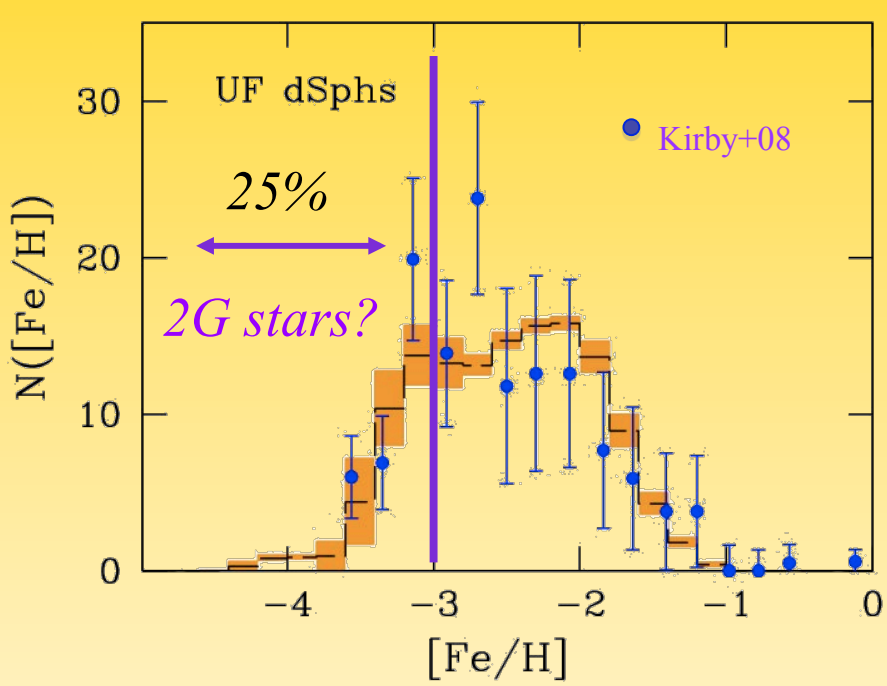
$0.1 < f_b/f_c < 0.5$

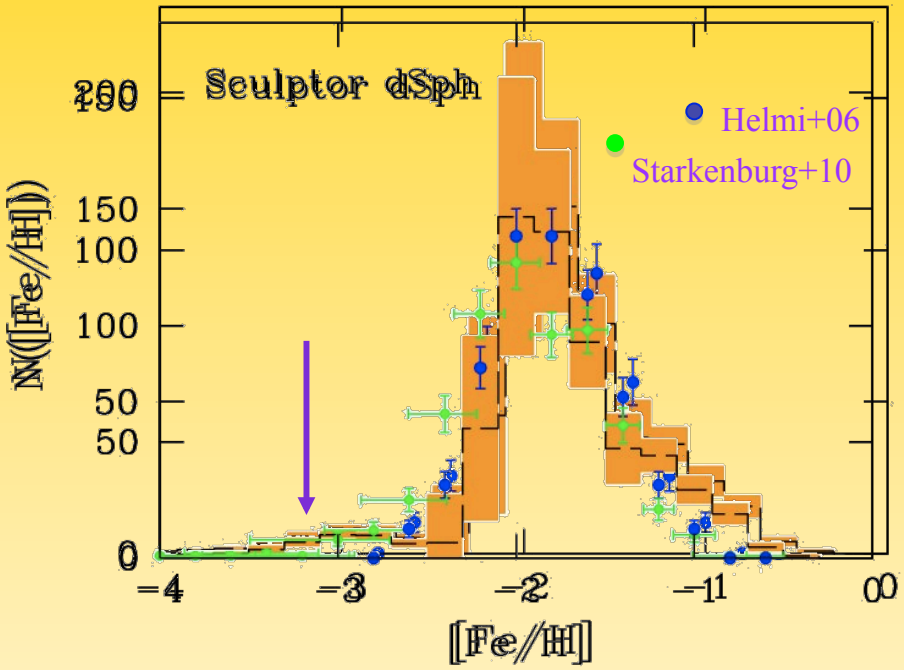
$f_b/f_c < 0.1$

UFs are left-overs of H_2-cooling minihaloes formed at $z > 8.5$

Ultra faint vs classical dSphs

Salvadori & Ferrara 2009





The MDF of UFs is shifted towards lower [Fe/H] values because of the lower GM metallicity at z_{form}

The chemical abundances of EMPs in UFs and in classical dSphs is expected to be the same → confirmed by new observations Simon+2010, Frebel+2010

Combining with N-body simulation

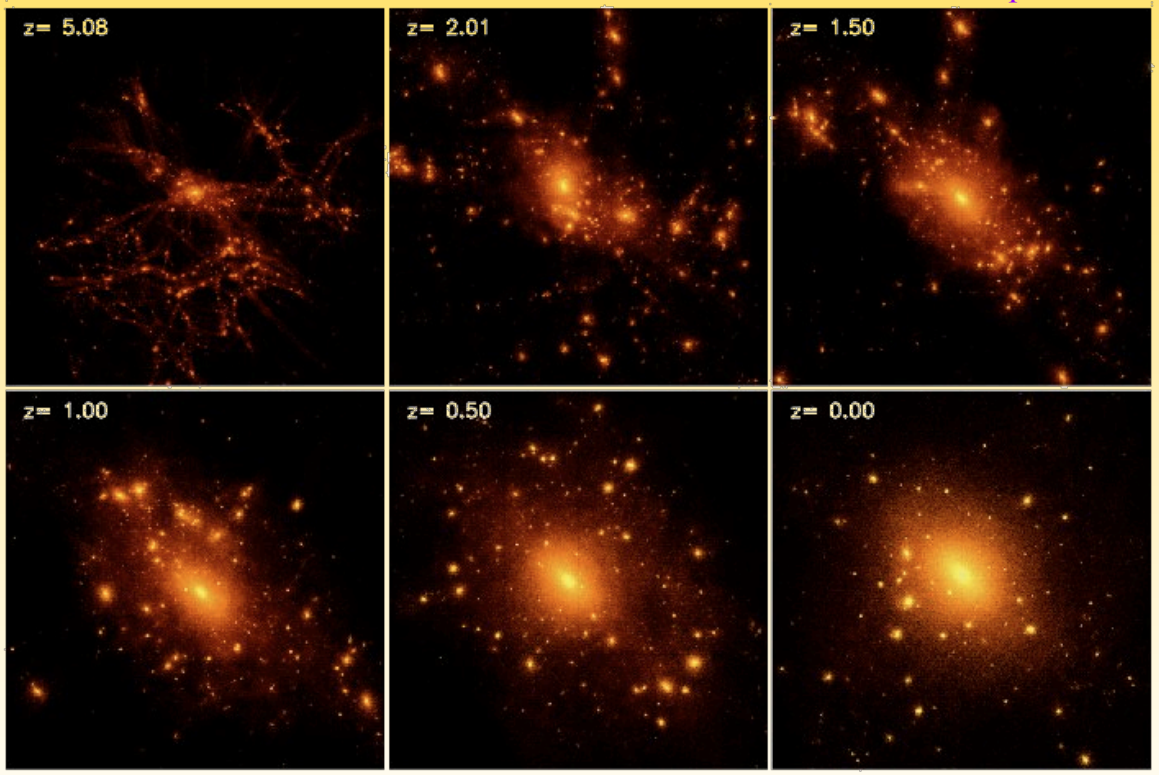
Salvadori, Ferrara, Schneider, Scannapieco & Kawata 2010

10^6 dark matter particles

$m_p = 7.8 \times 10^5 M_\odot$, $N_{min} = 50$

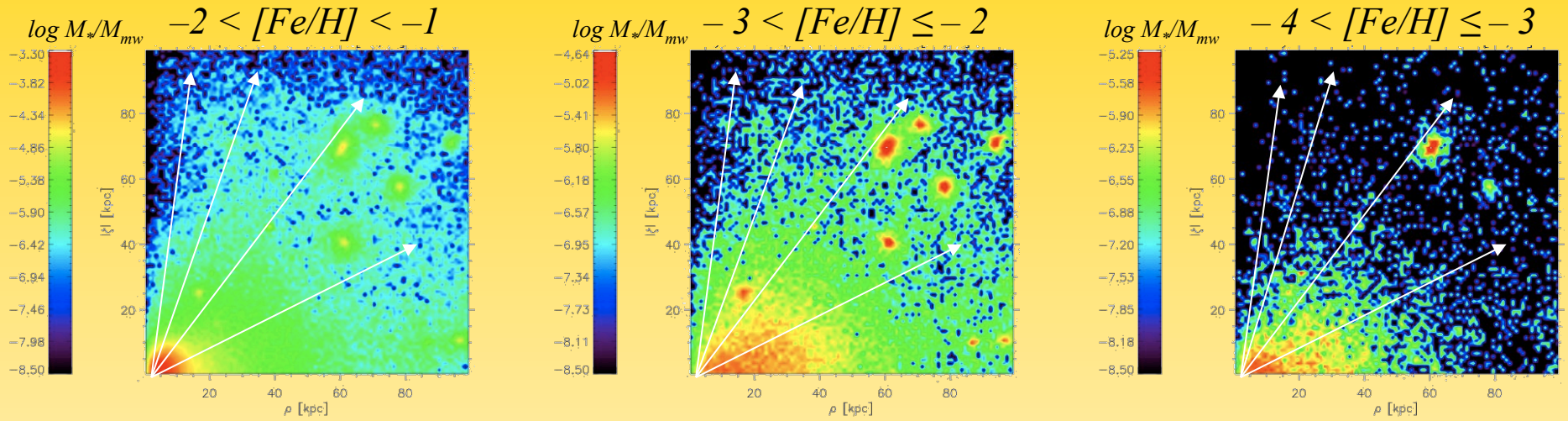
The HR region is a r ~ 1Mpc sphere

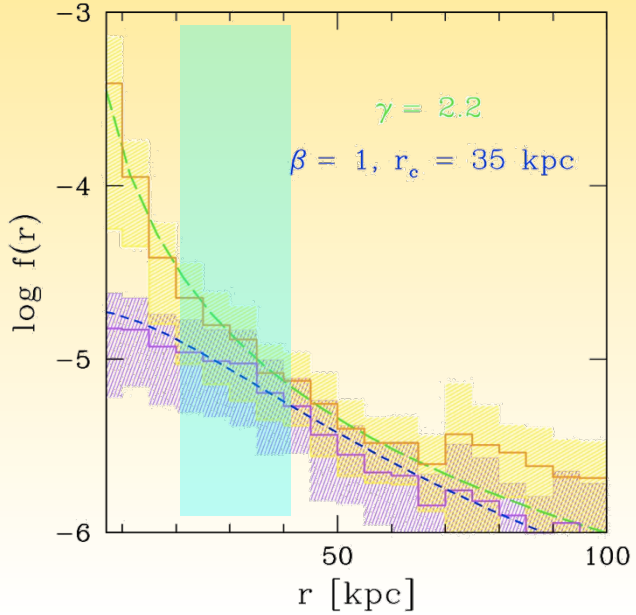
Scannapieco+06



Mapping the Galactic halo

Salvadori, Ferrara, Schneider, Scannapieco & Kawata 2010





The relative contribution of [Fe/H] < –2 stars increases from 17% for r < 20 kpc, to > 40% for r > 20 kpc

(Carollo+08/09, De Lucia & Helmi 08, Zolotov+09)

The outer halo between 20 kpc ≤ r ≤ 40 kpc represents the most promising region to search for VMP stars

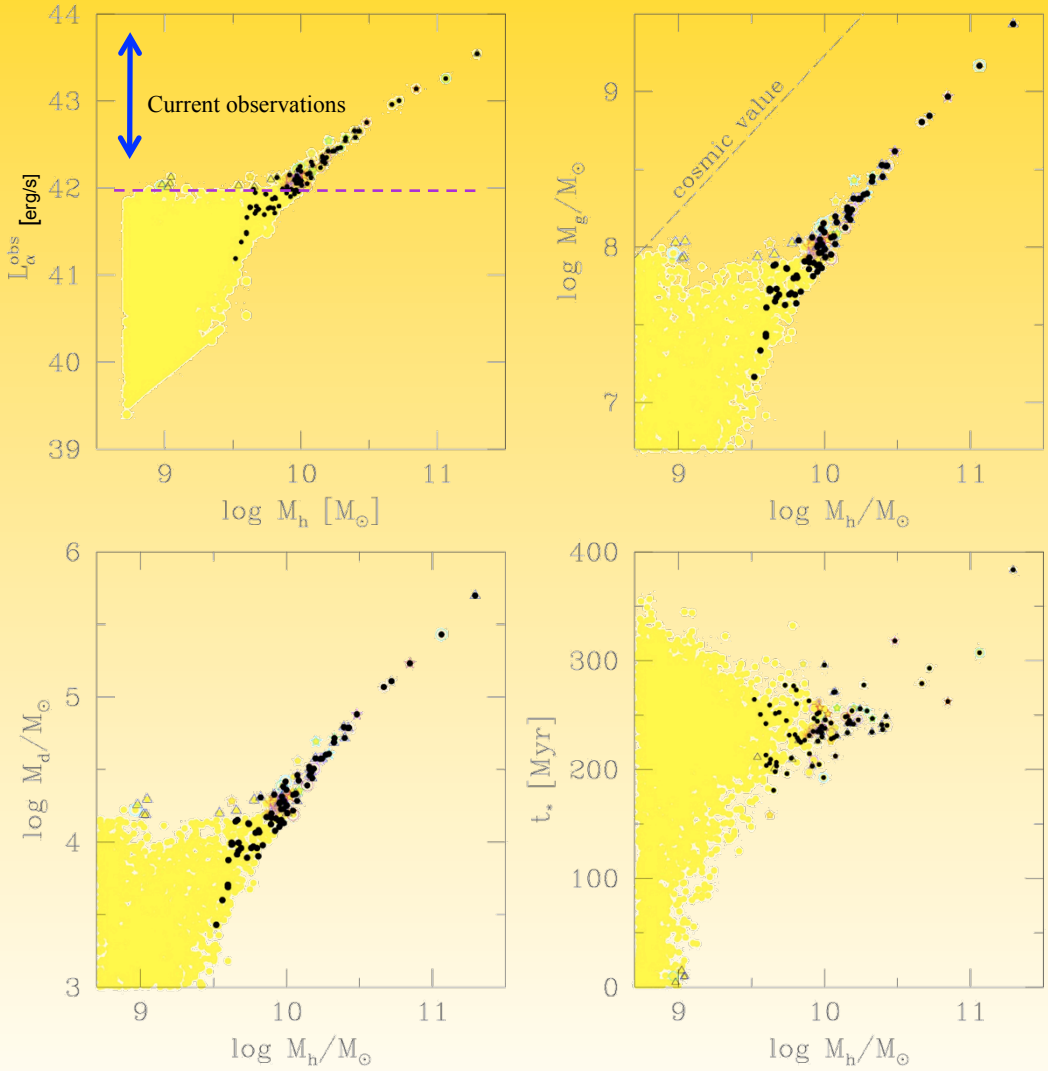
Can we see the MW in its infancy?

Salvadori, Dayal & Ferrara, MNRAS sumbitted

$z \approx 5.7$

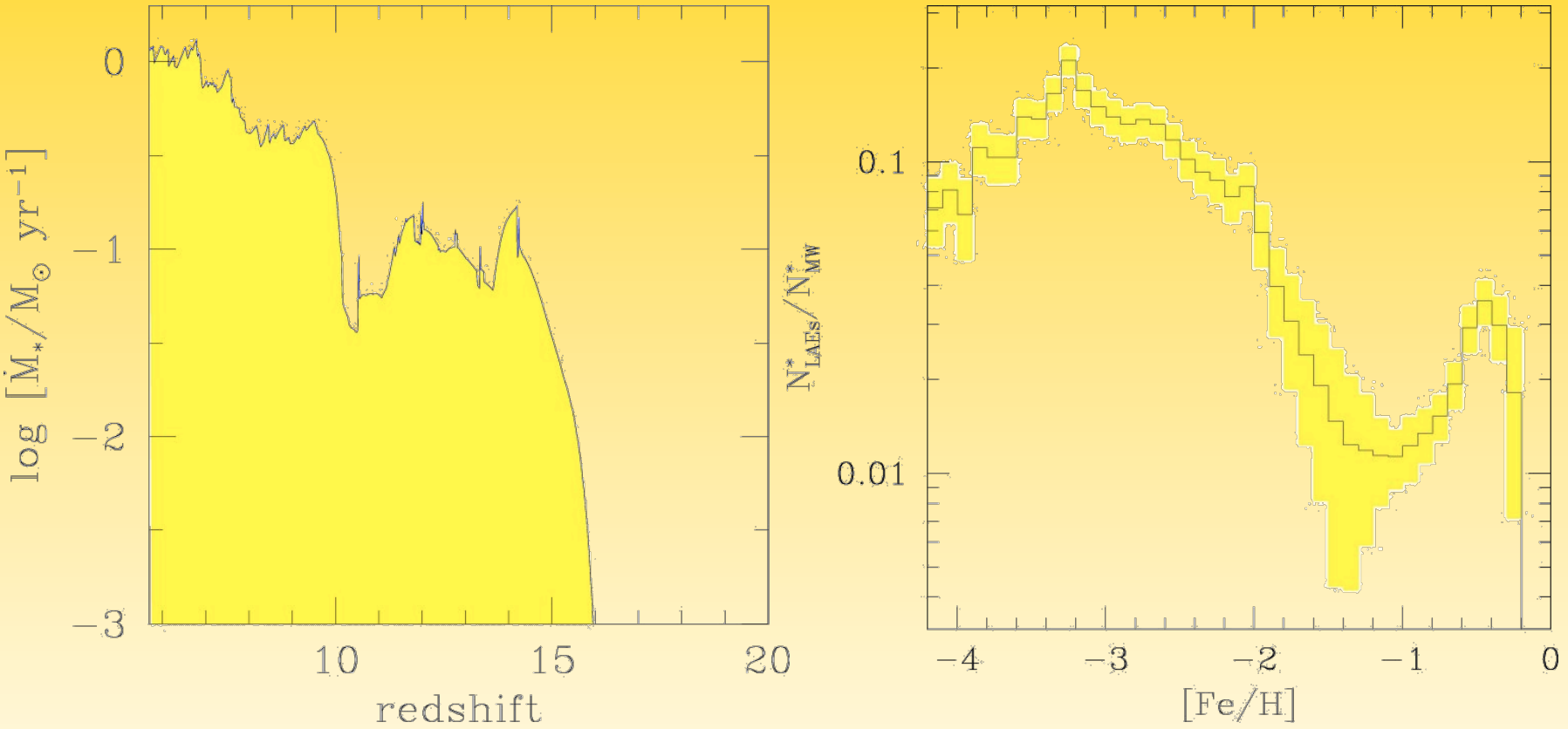
$L_\alpha > 10^{42}$ erg/s

EW > 20 A



The most massive progenitors of MW-like galaxies can be seen as LAEs at $z \approx 5.7$

MW progenitors visible as LAEs



The MW progenitors visible as LAEs at z ≈ 5.7 provide more than the 10% of the very metal-poor stars observed today in the Galactic halo

Conclusions

- *UFs are left-overs of H_2-cooling minihaloes (Bovill & Ricotti 09; Muñoz+09) formed at $z > 8.5$ i.e. before the end of reionization ($z_{rei} = 6$).*
- *They are the oldest and most dark matter dominated dSphs in the MW system with a total mass $M_h = 10^{7-8} M_\odot$ and $M/L = 10^{2-4}$ (Simon & Geha07; Geha+08).*
- *The MDF of UFs is shifted towards lower [Fe/H] values with respect to classical dSphs because of the lower GM metallicity at the formation epoch.*
- *UFs are the best objects to search for extremely metal-poor stars (2G stars?)*
- *The outer halo, between 20 kpc < r < 40 kpc, is the most promising region to select very metal-poor stars.*
- *By looking at the faintest LAEs observed at $z \approx 5.7$ we can see the MW in its infancy when it was only 1Gyr old.*