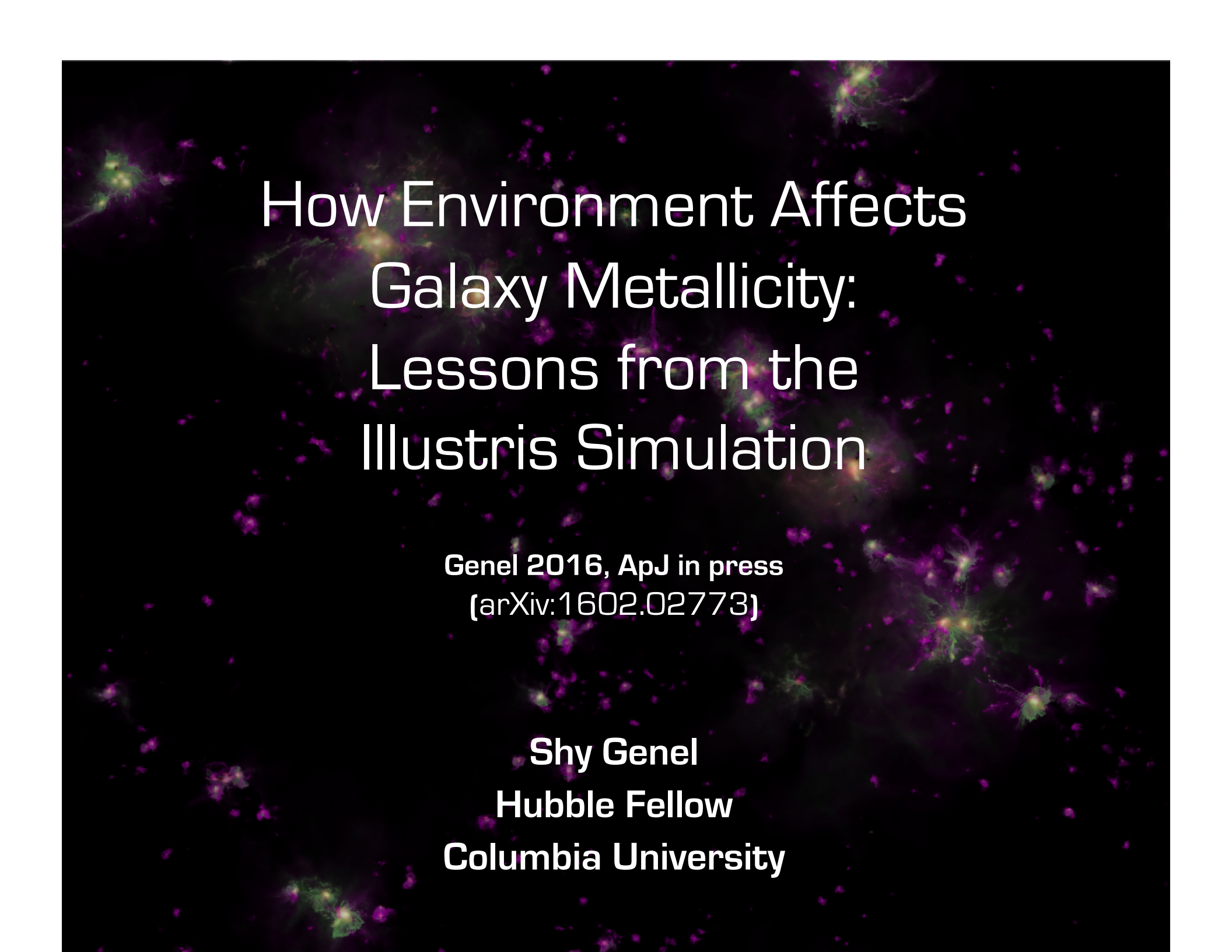


The background of the slide is a visualization of the cosmic web from the Illustris simulation. It shows a dark space filled with a complex network of purple and green filaments, representing gas and dark matter. Numerous bright yellow and green points are scattered throughout, representing individual galaxies and star-forming regions.

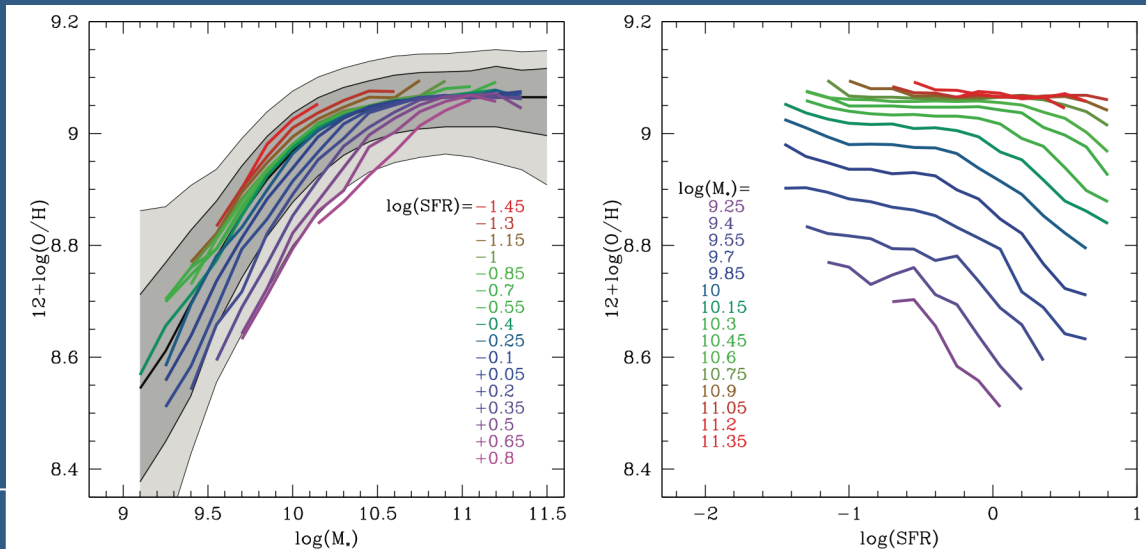
How Environment Affects Galaxy Metallicity: Lessons from the Illustris Simulation

**Genel 2016, ApJ in press
(arXiv:1602.02773)**

**Shy Genel
Hubble Fellow
Columbia University**

Motivation

- Z increases with M_* , decreases with SFR, independent of z (?)
- Used to constrain models, BUT: systematics!
- Motivations to look at **other dependencies**:
 - Weaker/different systematics
 - Constrain additional/different physical processes

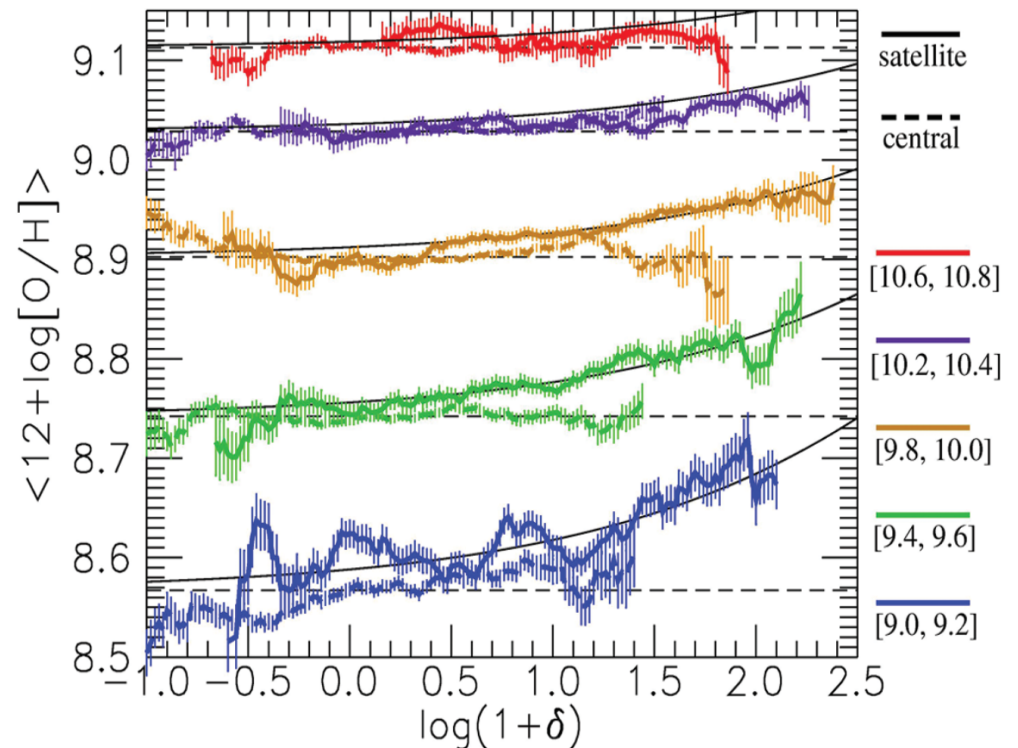
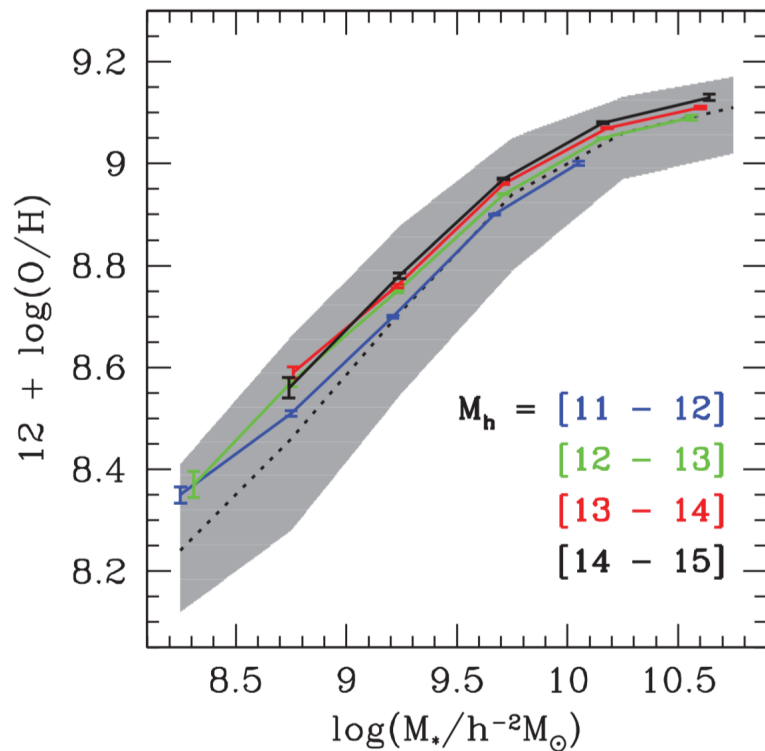


Mannucci et al. 2010

Metallicity and environment – $z=0$ obs.

The role of
cluster membership:

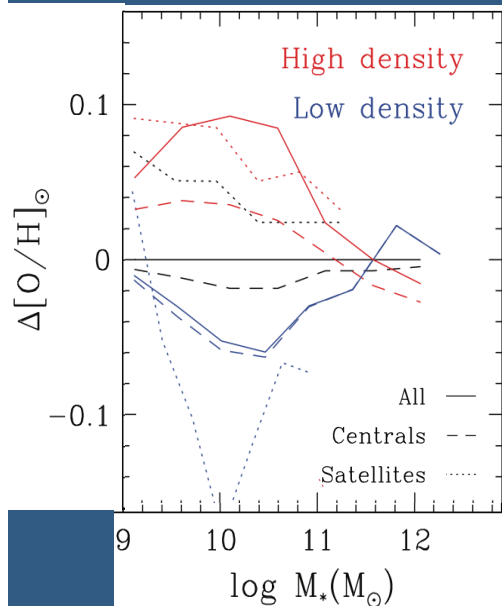
The role of
environmental density:



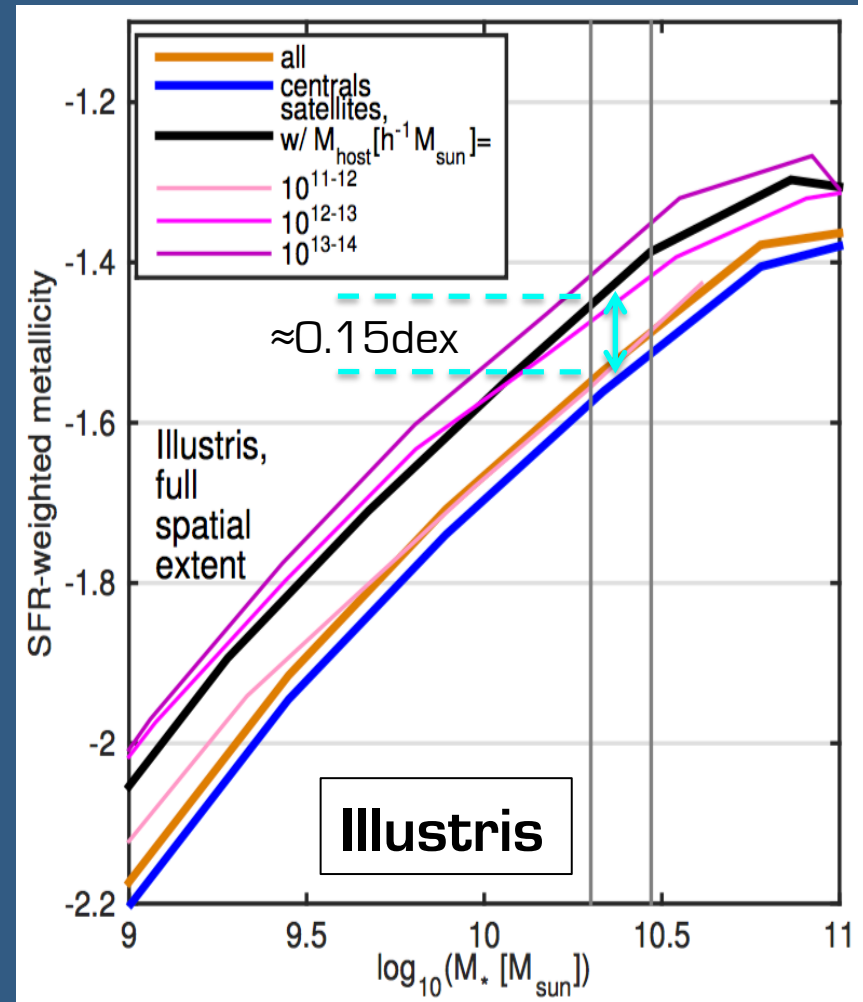
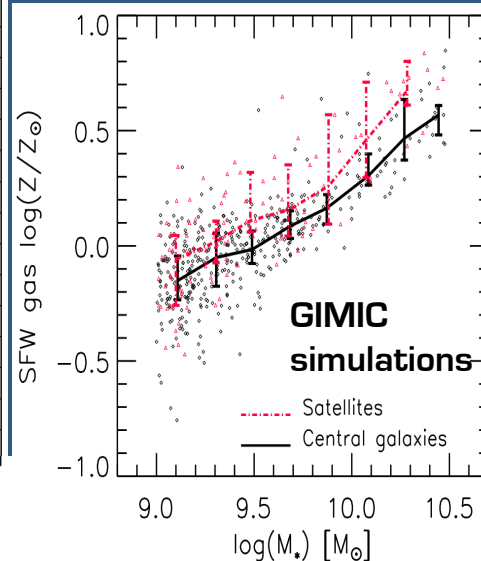
Metallicity of satellites – simulations

- Illustris satellites have higher metallicities than centrals, at a given mass, by ≈ 0.1 - 0.15 dex
- Found in other simulations too, but never explained

Davé et al. 2012



De Rossi et al. 2015



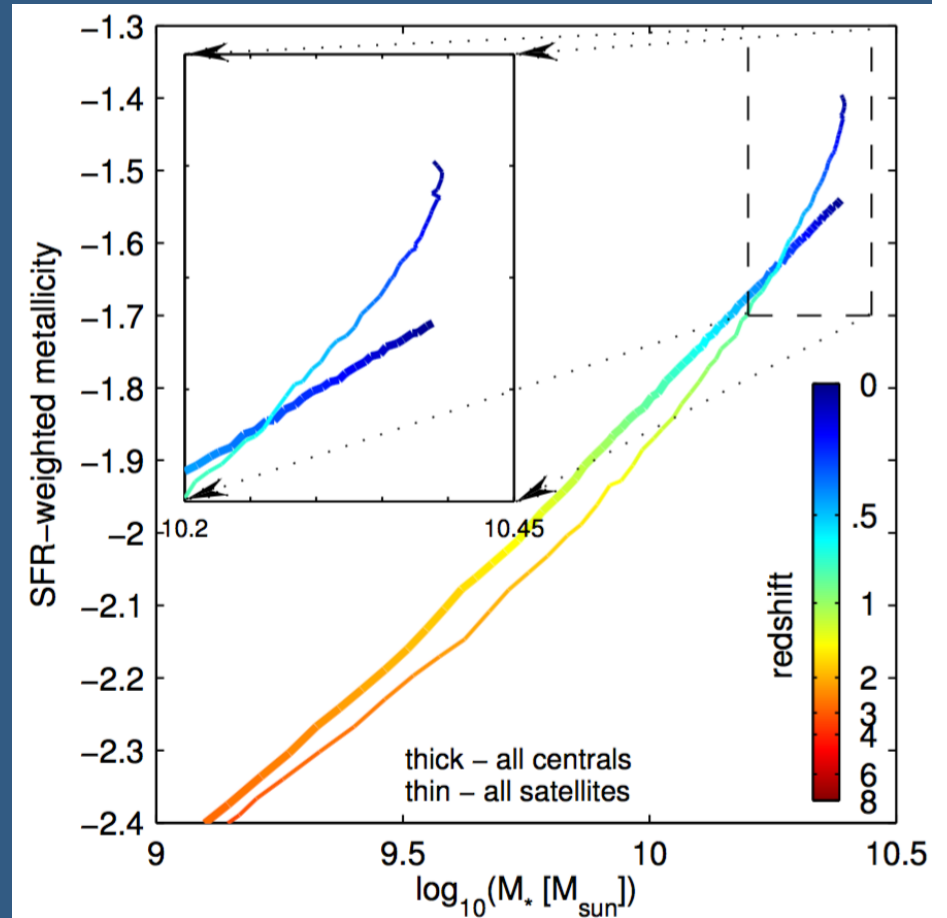
Metallicity evolution in Illustris

Thick – centrals

Thin – satellites

The metallicity of satellites increases at late times with very little increase in mass

Is this driven by the anti-correlation of metallicity & SFR?



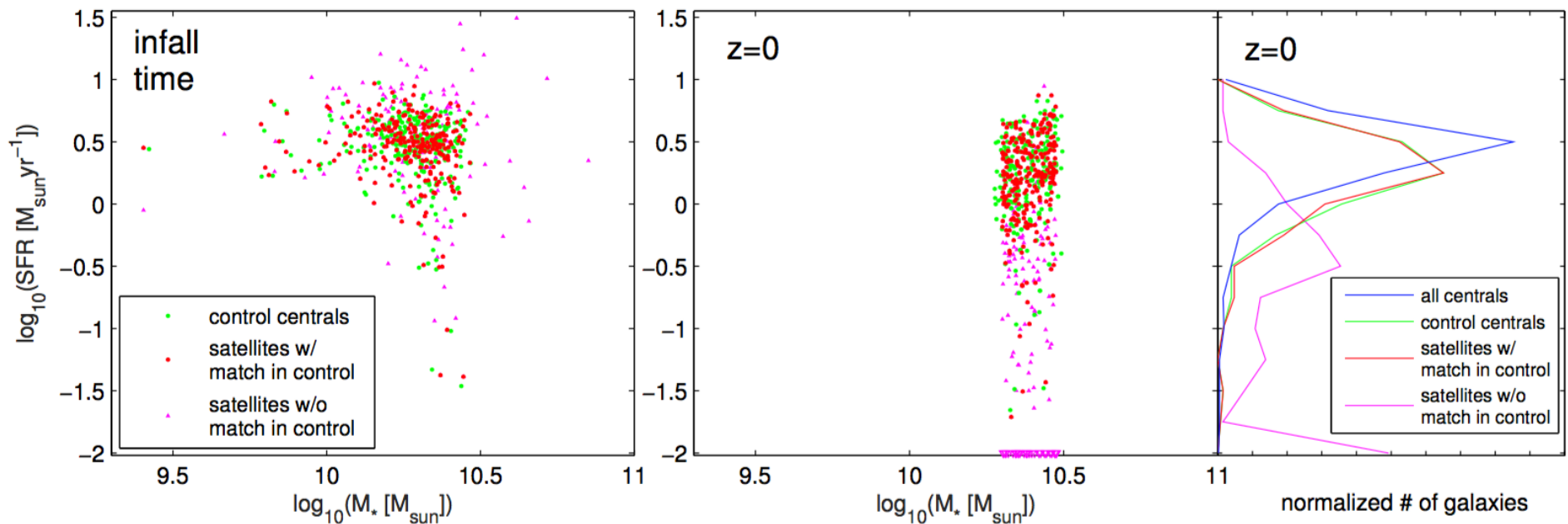
Samples: definitions

- Define a control sample of centrals, selected to match the satellites in:
- Both **mass** and **SFR**
- Both at **$z=0$** and at **infall time**

control

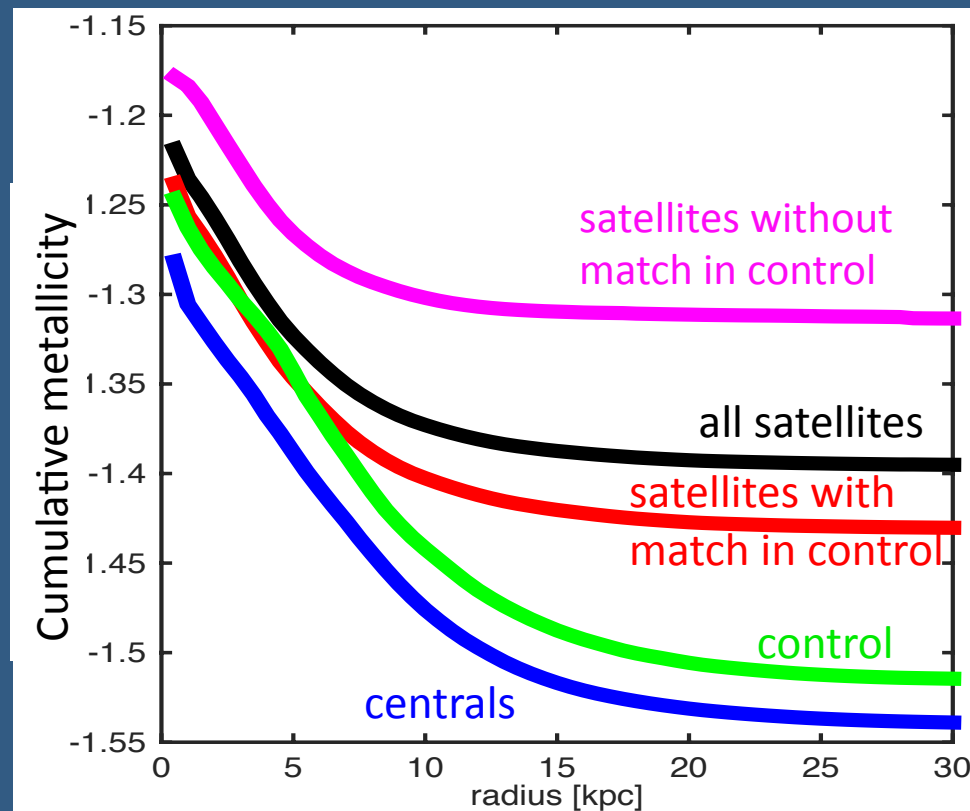
satellites with
match in control

satellites
without match in
control



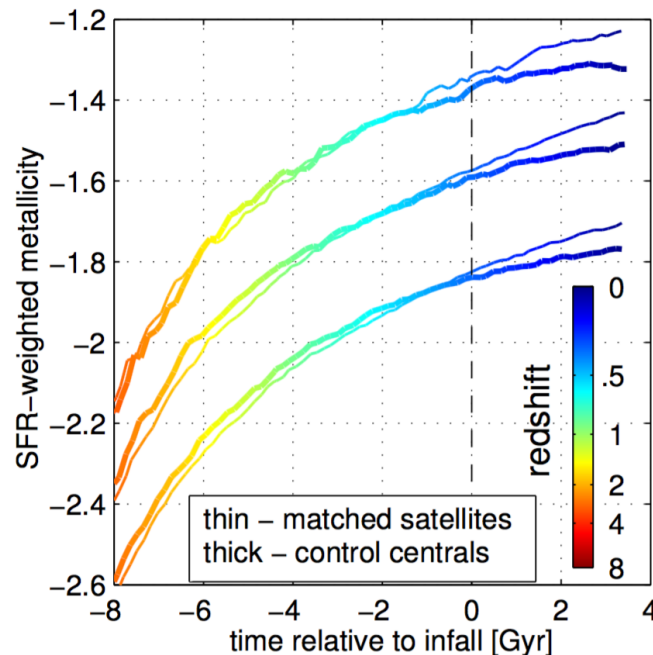
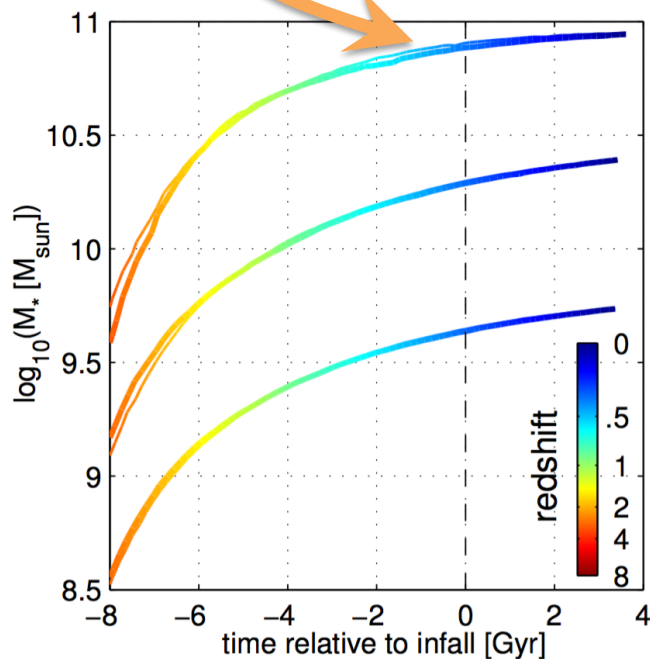
Samples: the role of SFR history

- The metallicity difference between the 'matched satellites' and their 'controls' accounts for $\approx 2/3$ of the total difference between satellites and centrals $\rightarrow$ differences in SFR history account for $\approx 1/3$ of the difference



Metallicity evolution in Illustris

The metallicity evolutions of the 'matched satellites' and their 'controls' **diverge after infall time**, approx. by the 'required' ≈ 0.1 dex, **in spite of almost identical SFR histories**

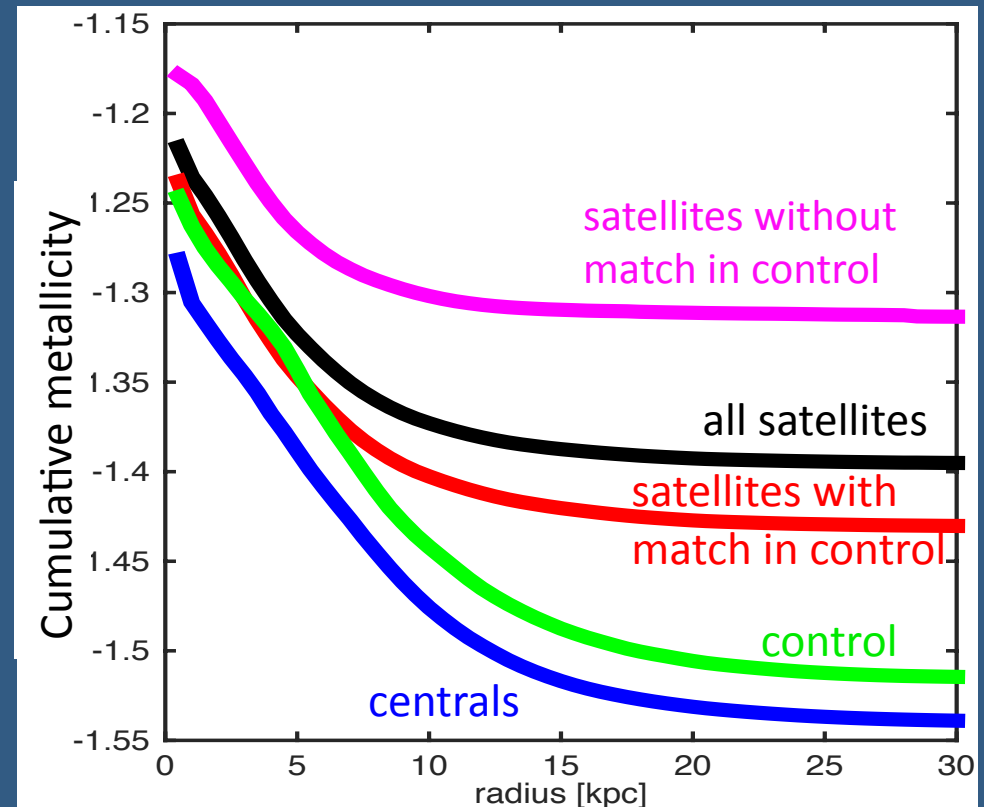


Thin -
satellites with
match in
control

Thick - control

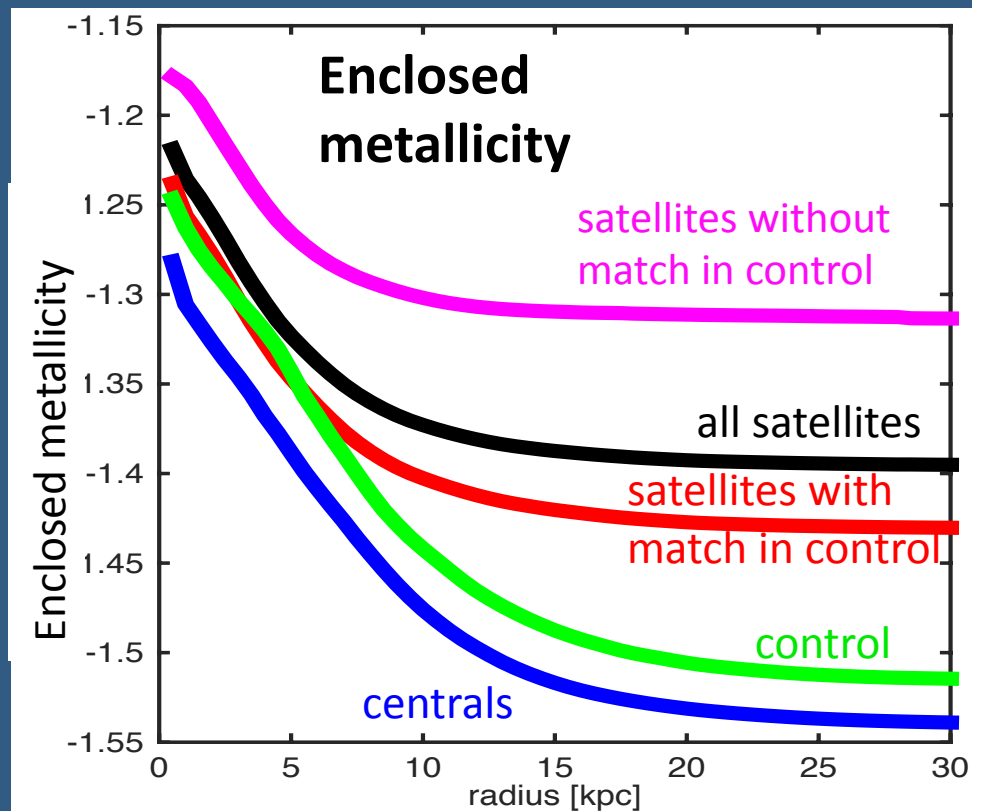
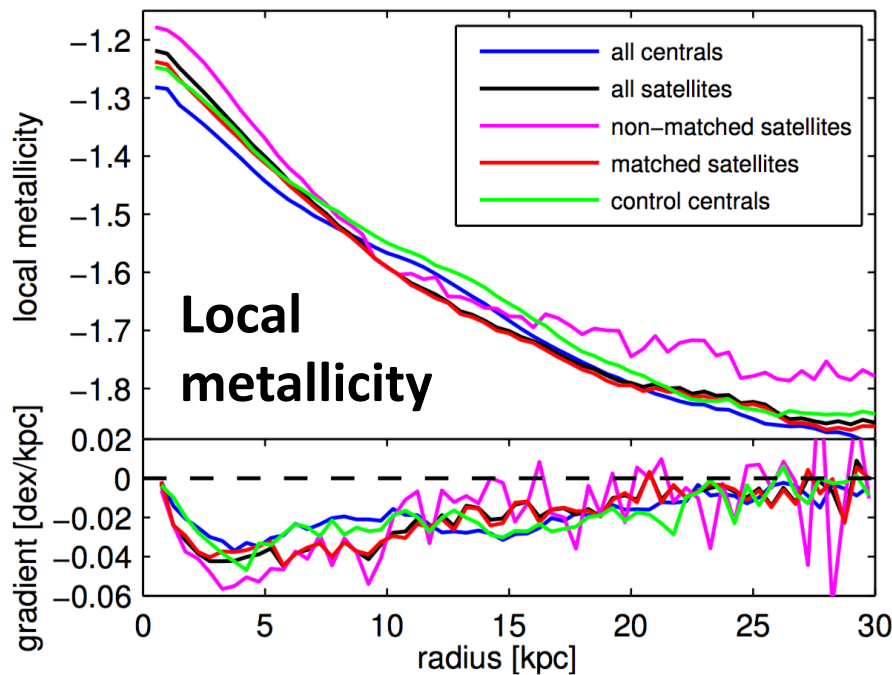
Metallicity profiles in Illustris

This metallicity difference between the matched samples emerges only in the 'outer' part, while in the inner part the matched samples have the same metallicities



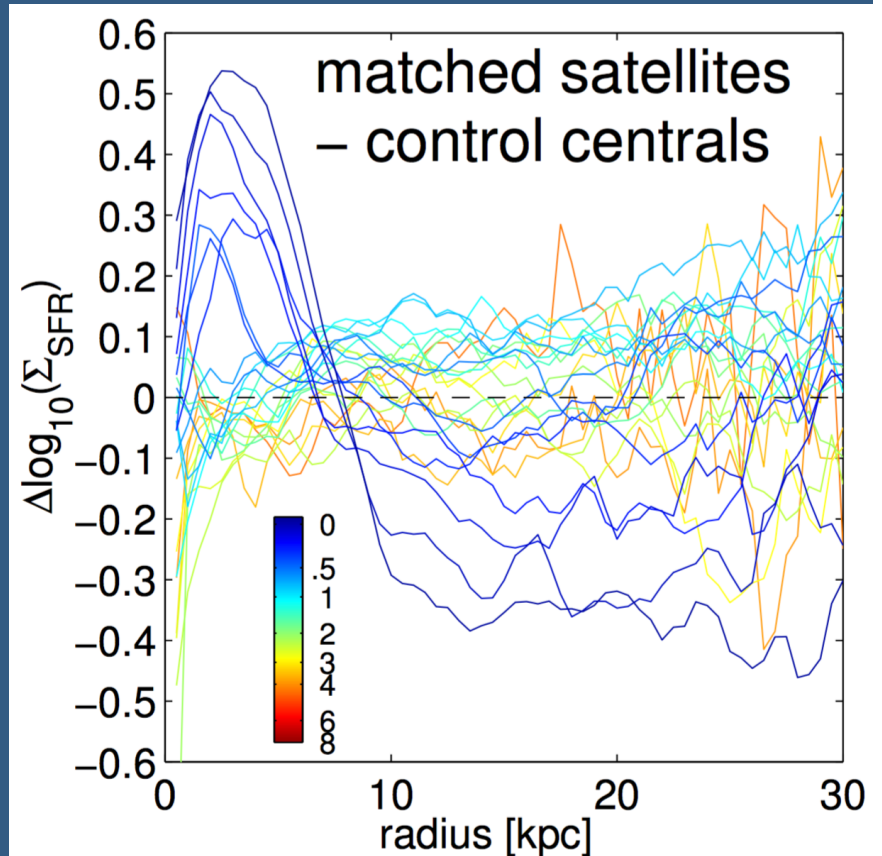
Metallicity profiles in Illustris

- The local metallicity of the matched samples is essentially identical
- Can only be reconciled through a different weighting of different radii



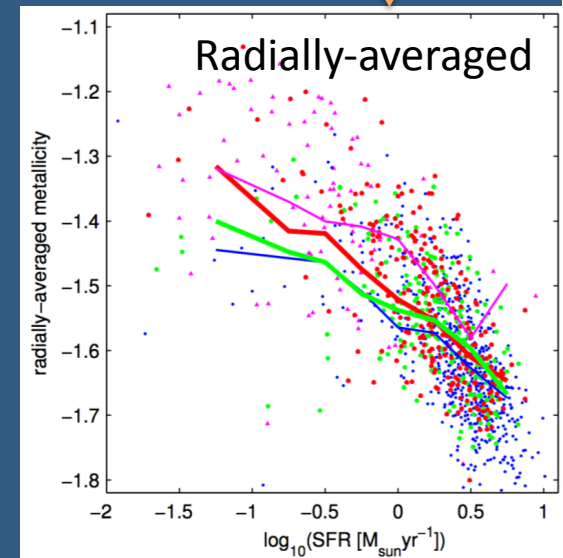
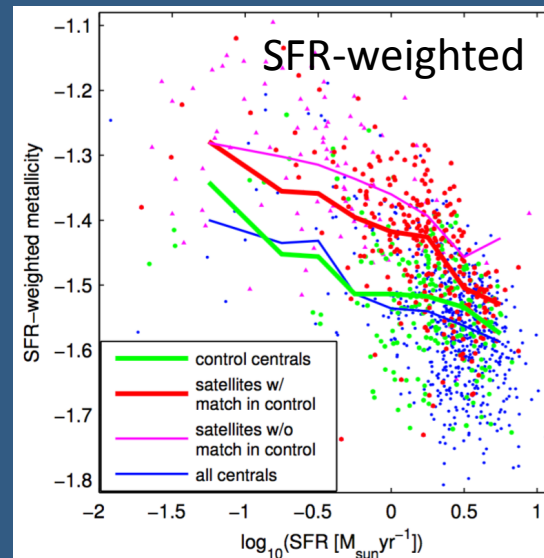
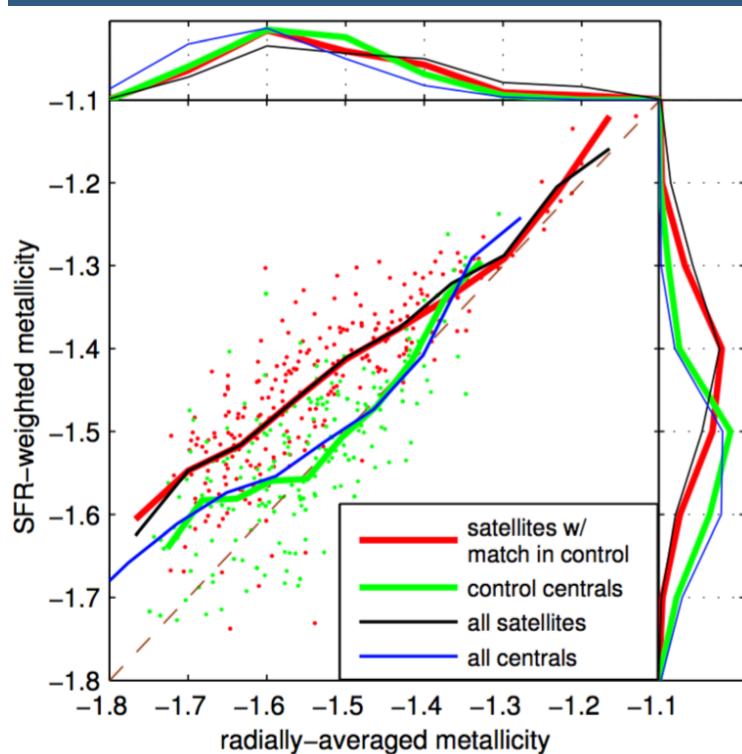
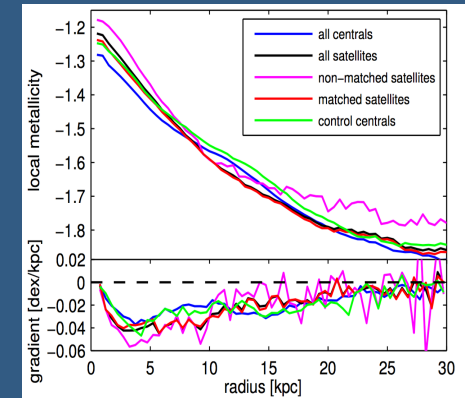
SFR profiles in Illustris

- SFR profiles of satellites are more concentrated than those of centrals
- The metallicity differences tell us about the physics of star-formation in satellites
- Need data to compare to!
(CALIFA? SAMI? MaNGA?)



A new definition of metallicity

- With a 'radially-averaged' metallicity, the gap between the metallicities of the 'matched satellites' and their 'controls' is almost closed

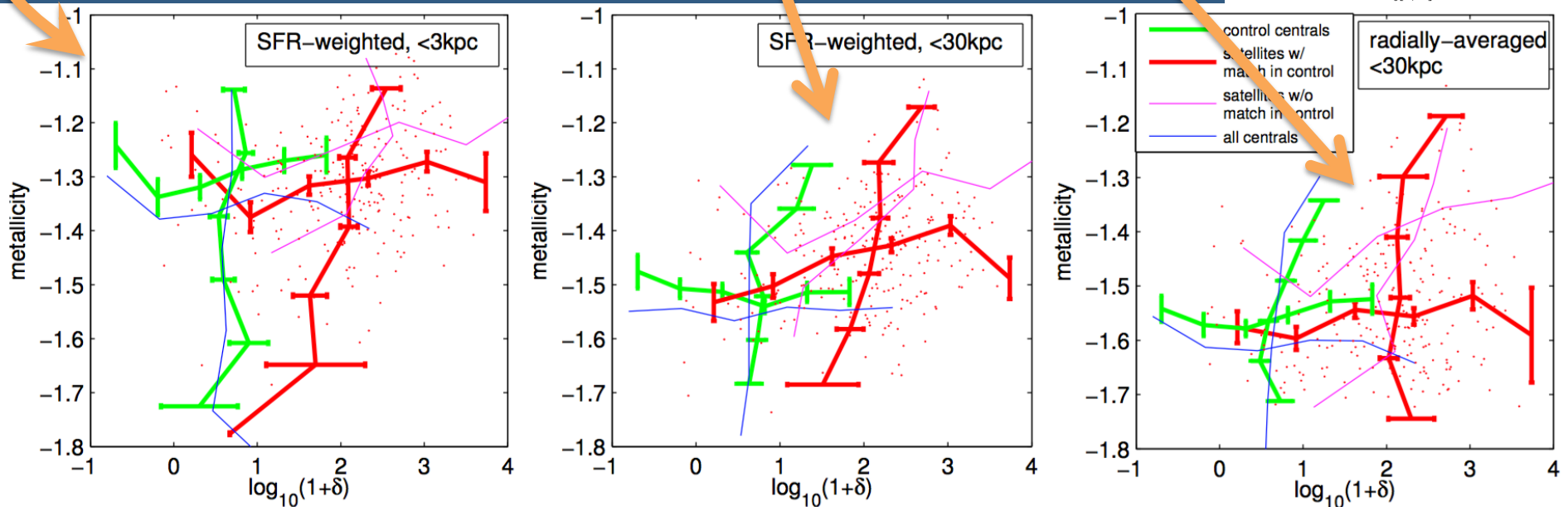
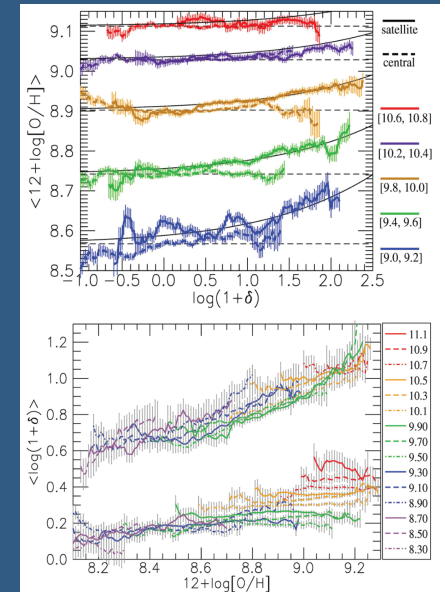


Metallicity and overdensity - Illustris

- Metallicity vs. environment & environment vs. metallicity:

positive correlation for **satellites**, none for **centrals**

- The effects is weaker for smaller radii, and is gone for the matched samples with radially-averaged metallicity



Conclusions

- Correlations between metallicity, galactocentric radius and environment provide independent constraints for models from the popular Z-M-z-SFR relations, and probe the physics of star-formation in satellites
- In Illustris, the difference between satellite and central galaxies in terms of the SFR profile dominates the difference in metallicities, due to different weighting of the metallicity gradient
- Weaker, 'local', metallicity differences are related to overall SFR history
- Predictions:
 - Radially-averaged metallicity differs less than SFR-weighted
 - Smaller differences when considering smaller apertures