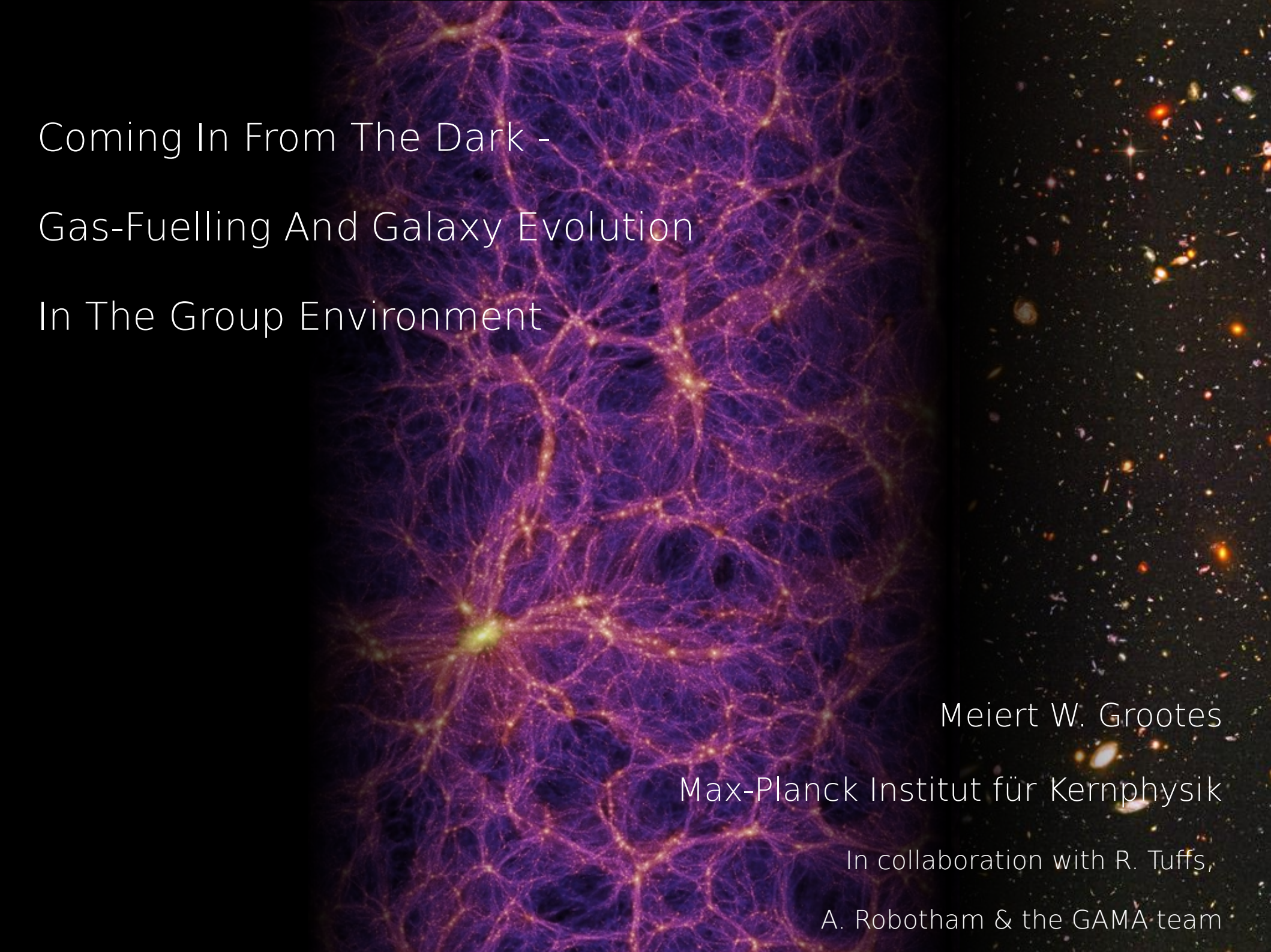
Coming In From The Dark - Gas-Fuelling And Galaxy Evolution In The Group Environment



Meiert W. Grootes

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In collaboration with R. Tuffs, A. Robotham & the GAMA team

Gas-Fuelling: Expectations

- Gas-fuelling is a function of environment (halo mass)

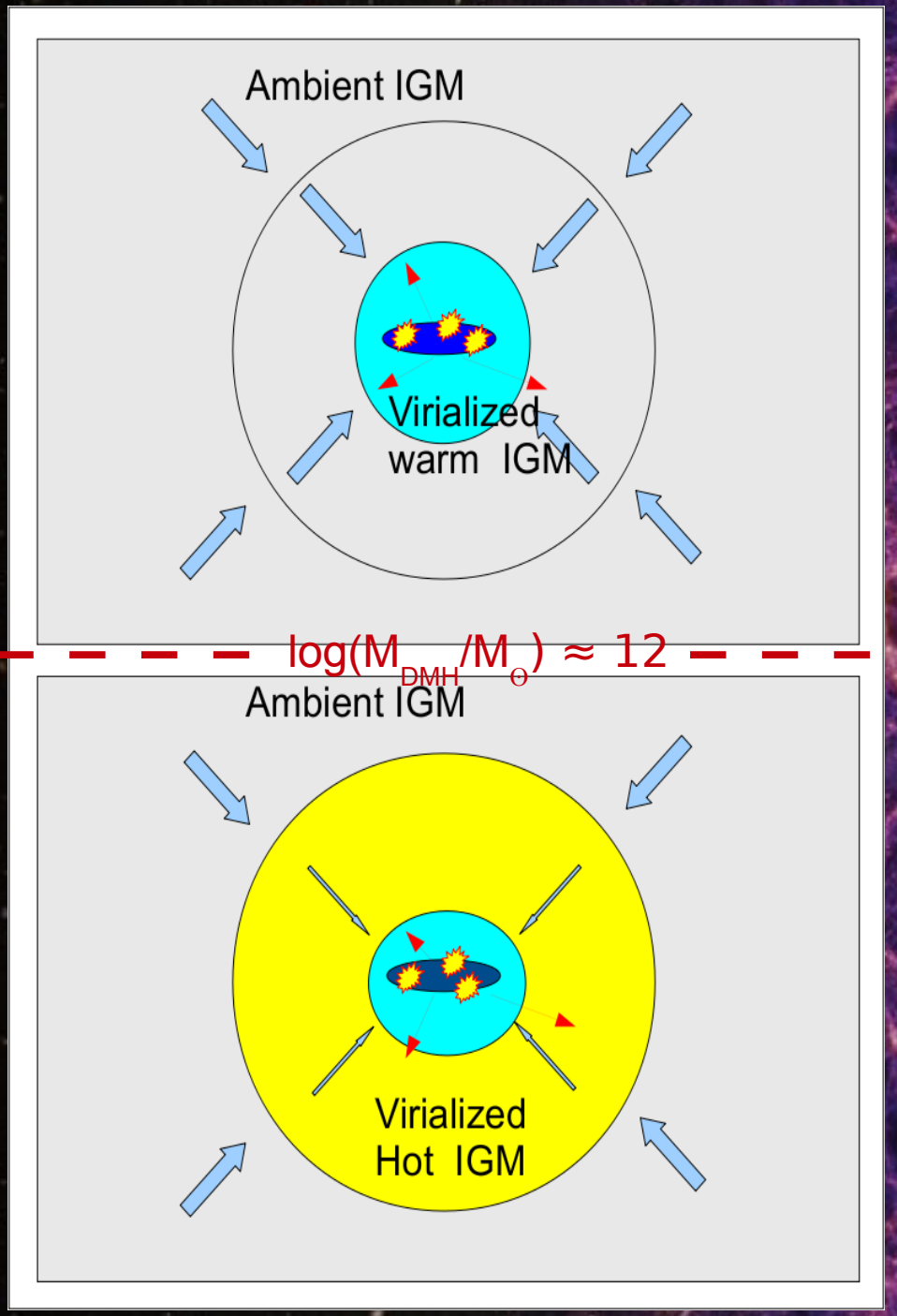
  Accretion mode

- Gas-fuelling is a function of galaxy properties (mass)

  Feedback (SF/AGN) with varying efficiency

→ Self-regulated balance

Cold Accretion



Hot Accretion

Gas-Fuelling: The Group Environment

≳40 % of galaxies reside in groups
(Eke+2004,Robotham+2011)

→ Central & Satellite Galaxies

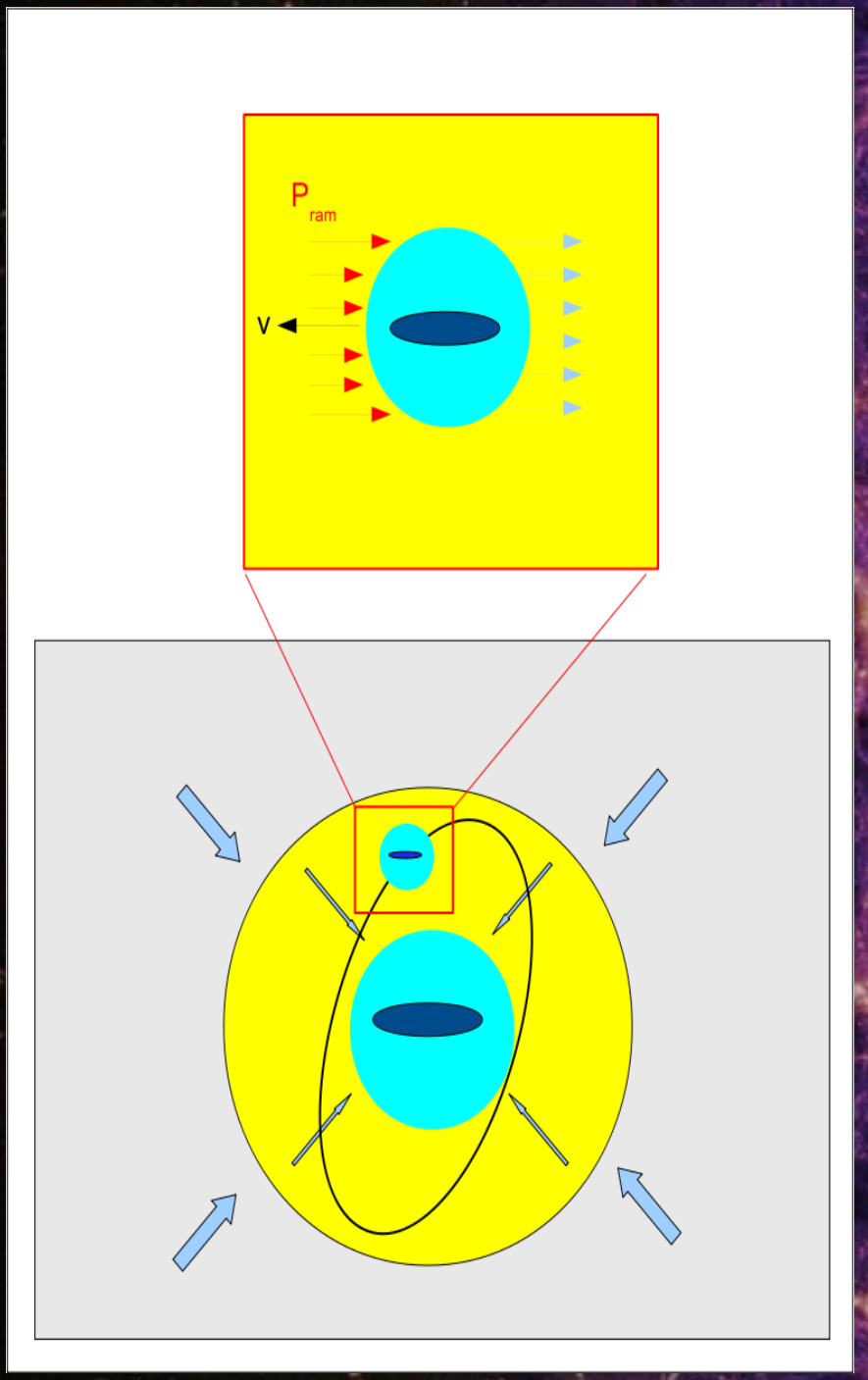
Satellite galaxies:

Ram-pressure stripping
(Gunn&Gott1978)

'Strangulation'
(Kimm+2008)

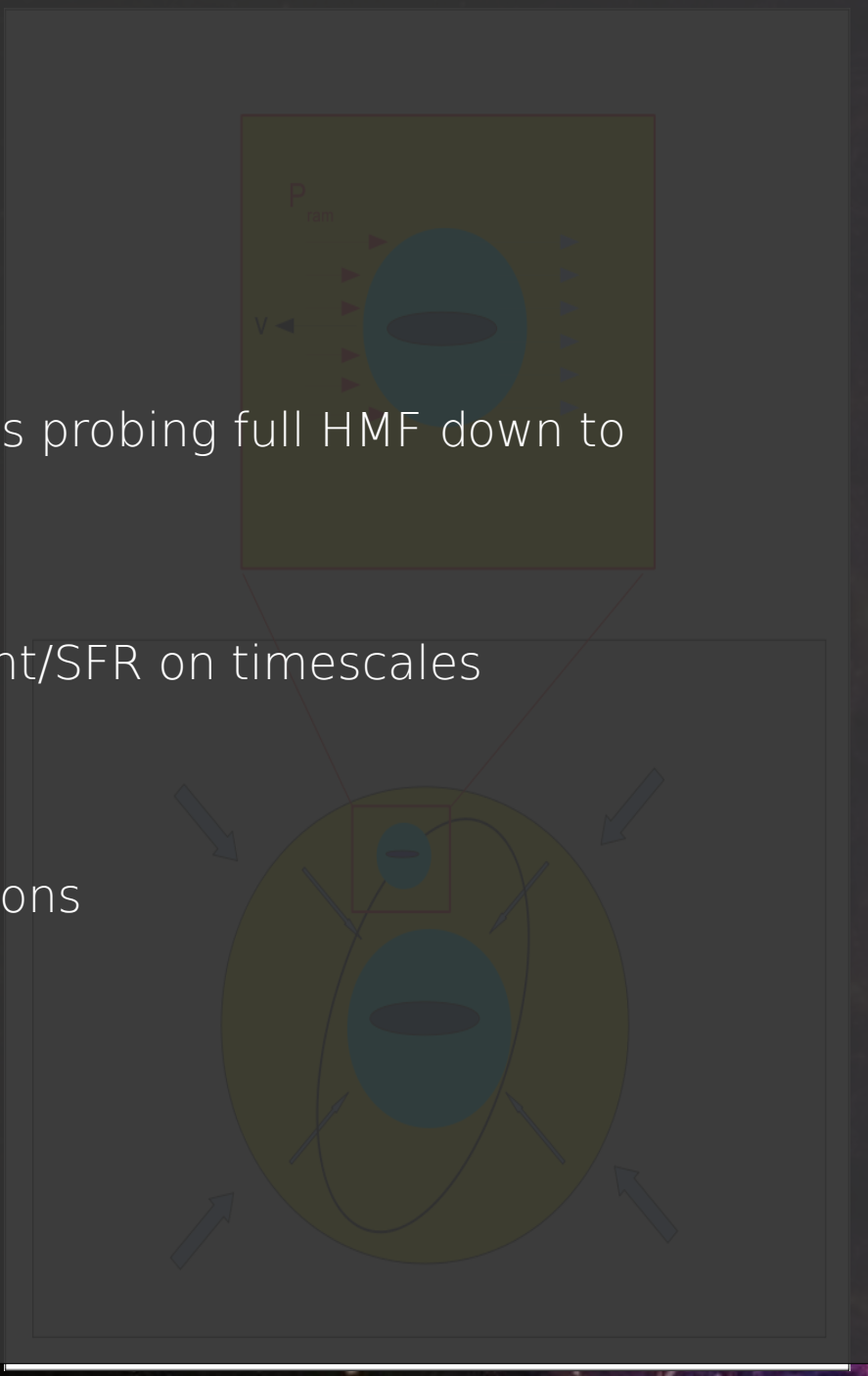
No gas-fuelling

Quenching of SF



Empirical reference

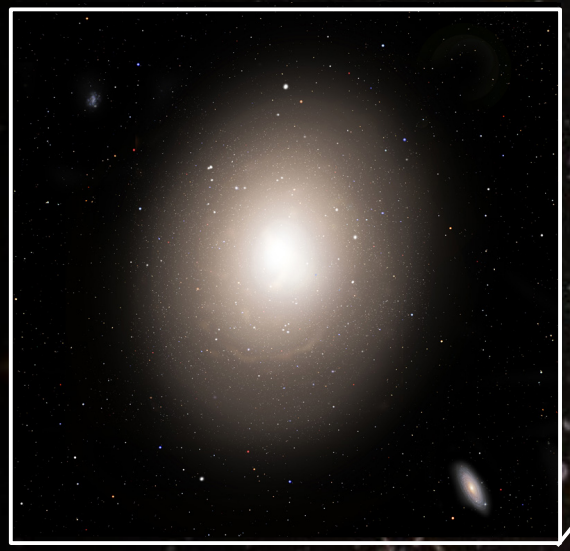
- Large statistical sample of galaxies probing full HMF down to $\log(M_{halo}/M_{\odot}) \approx 12$
- Sensitive to changes in gas-content/SFR on timescales $<< \tau_{dyn}$ (~1 Gyr)
- Control for galaxy-galaxy interactions



Observational Obstacles: Morphology

Dichotomy in galaxy morphology

- Different kinematics
- Different average colors/ sSFR
- Morphology – density relation



Credit: David A. Aguilar (CfA)

Credit: Adam Block/NOAO/AURA/NSF

Q: What drives difference in sSFR ?

Galaxy And Mass Assembly: Creating an empirical reference

GAMA

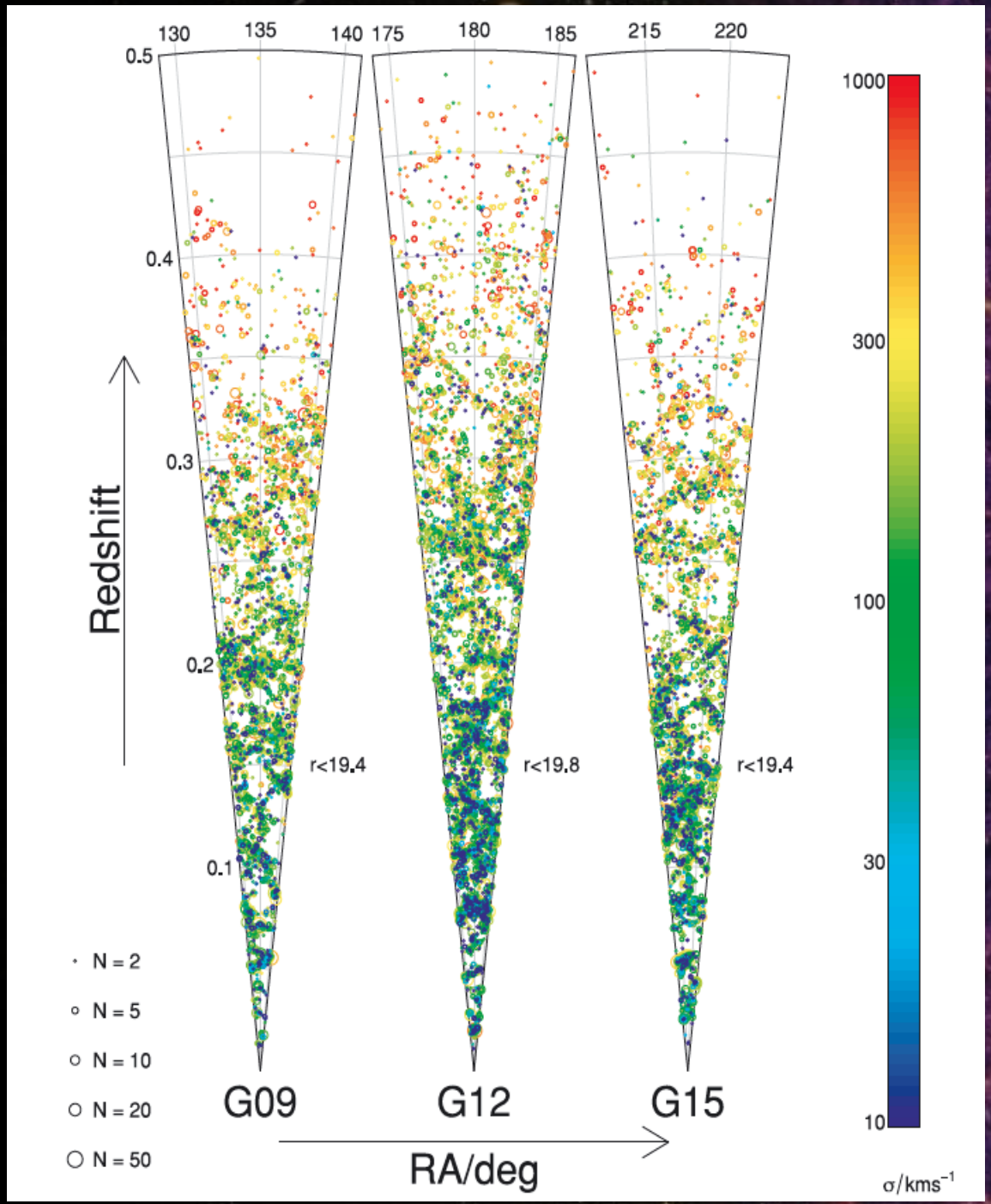
Driver+2011

300k redshifts

300 deg^2

> 98% target completeness, even in crowded regions

Unprecedented characterization of cosmic web and galaxy groups over z=0-0.5



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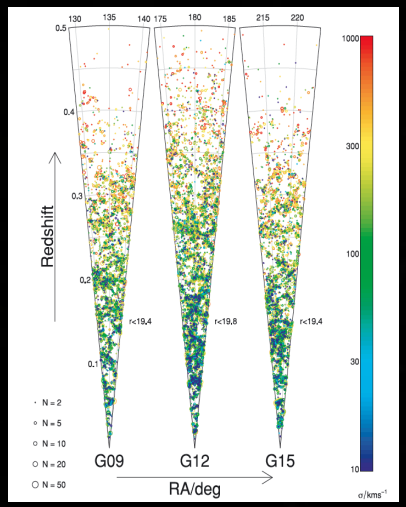
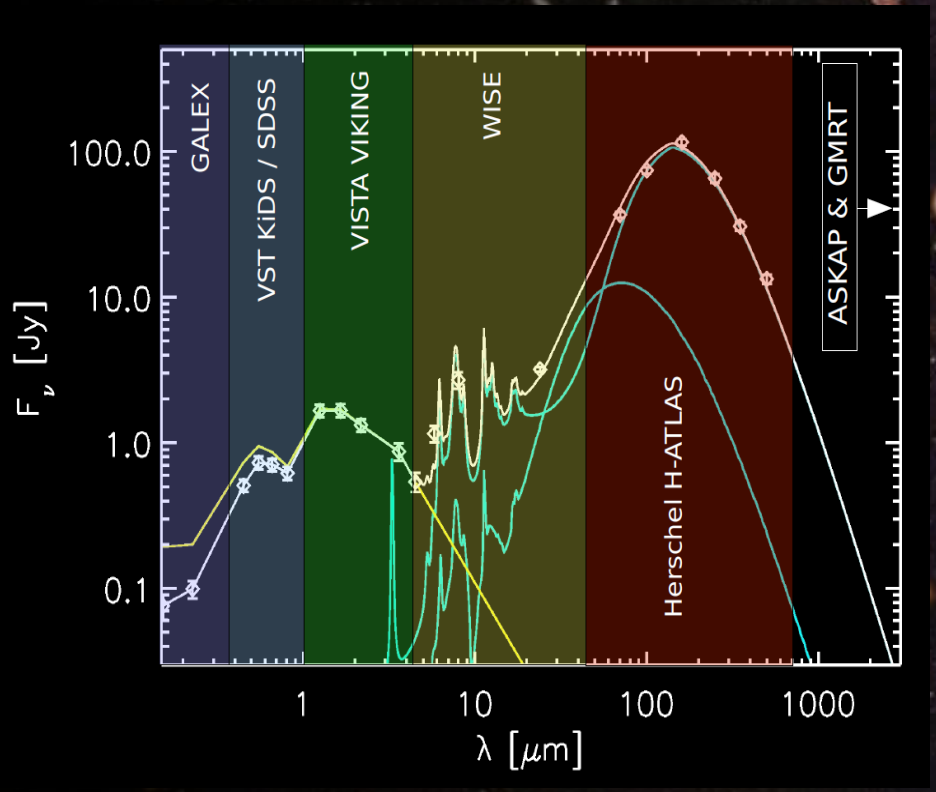
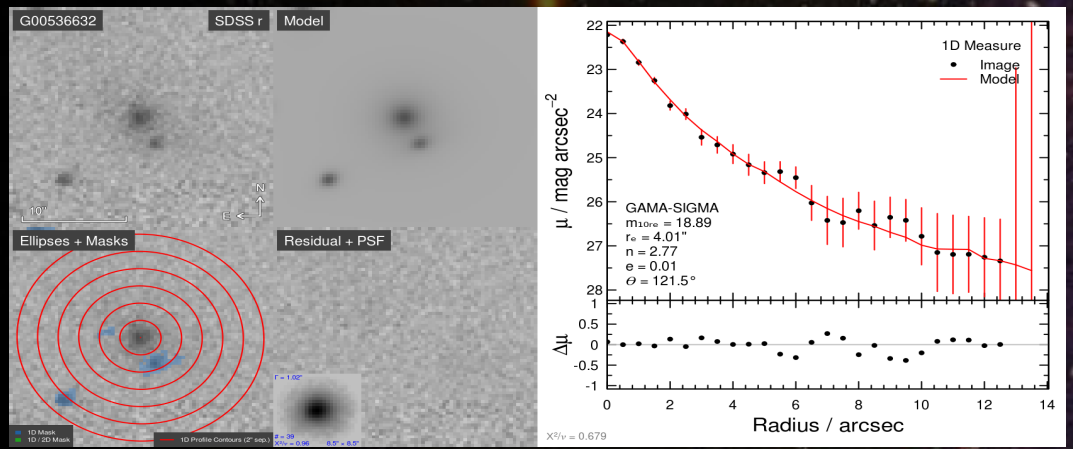
Spineto 10.06.2015

Galaxy And Mass Assembly: Creating an empirical reference







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Galaxy And Mass Assembly: Creating an empirical reference

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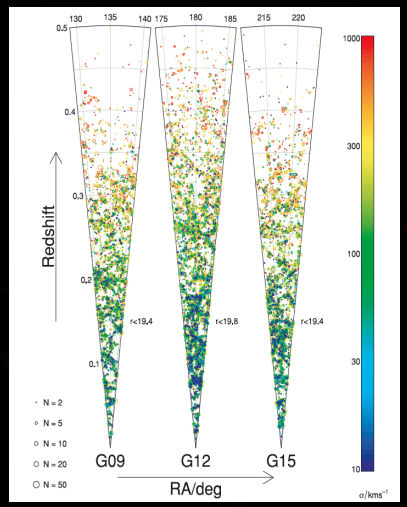
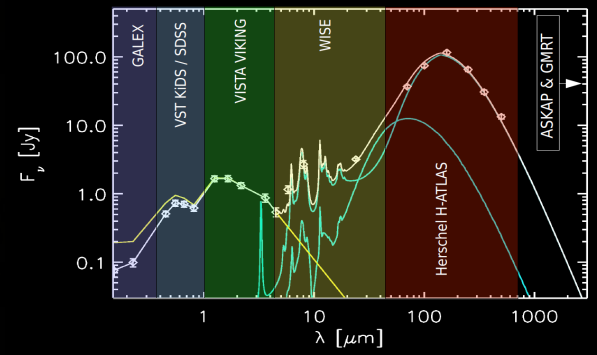
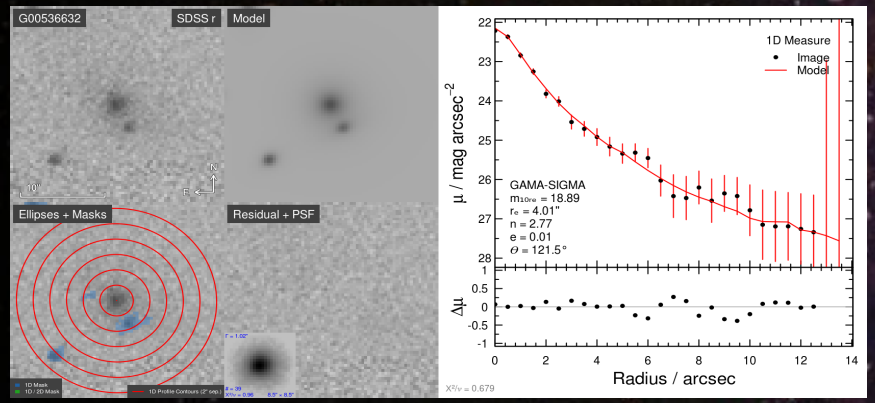


Construction of pure and complete morphologically selected sample of spiral galaxies using a new purpose built method (Grootes+2014)

Determination of highly accurate star formation rates using radiative transfer modelling techniques applied to large samples (Popescu+11, Grootes+13)





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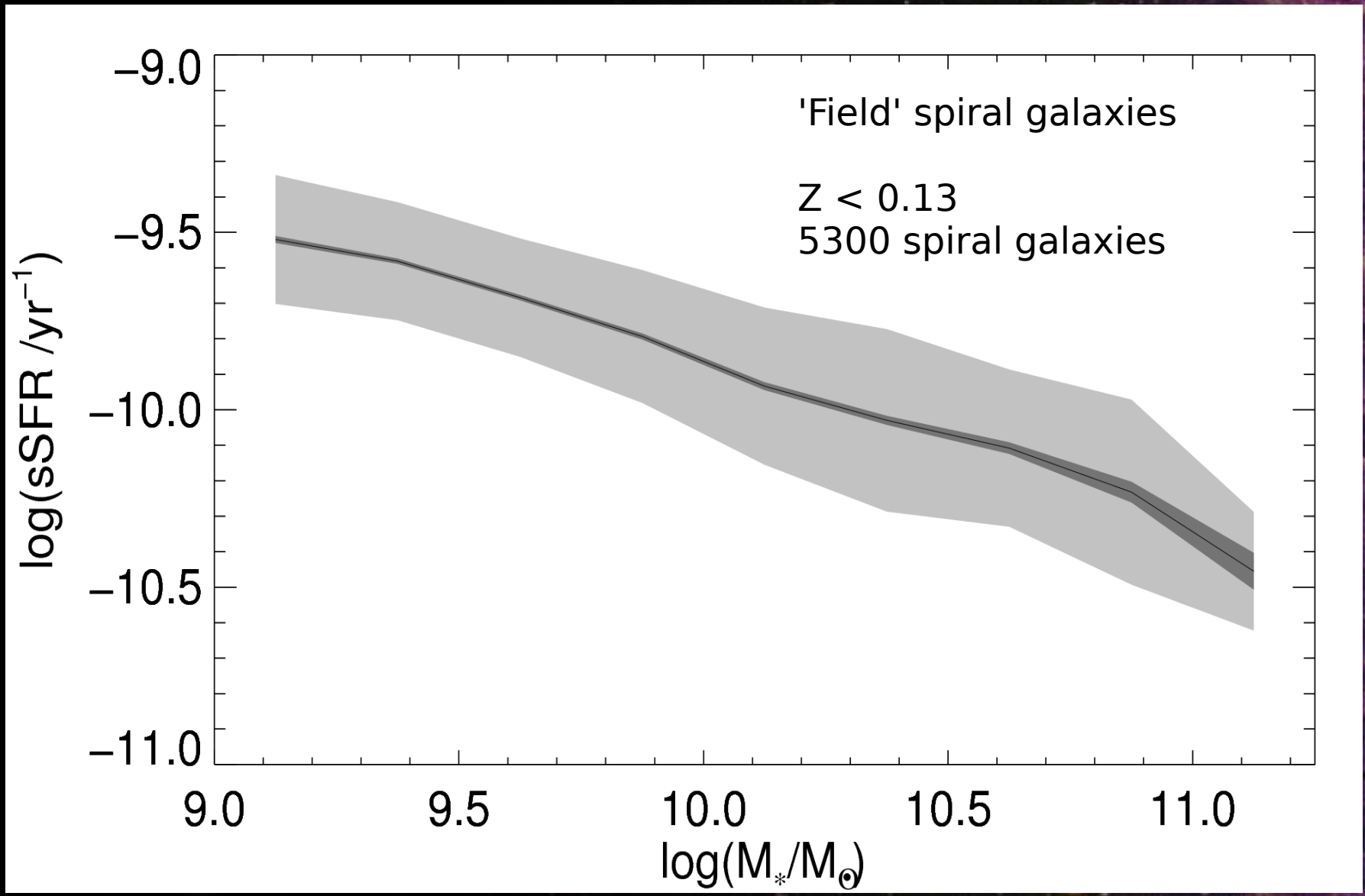
Main sequence of 'Field' spiral galaxies



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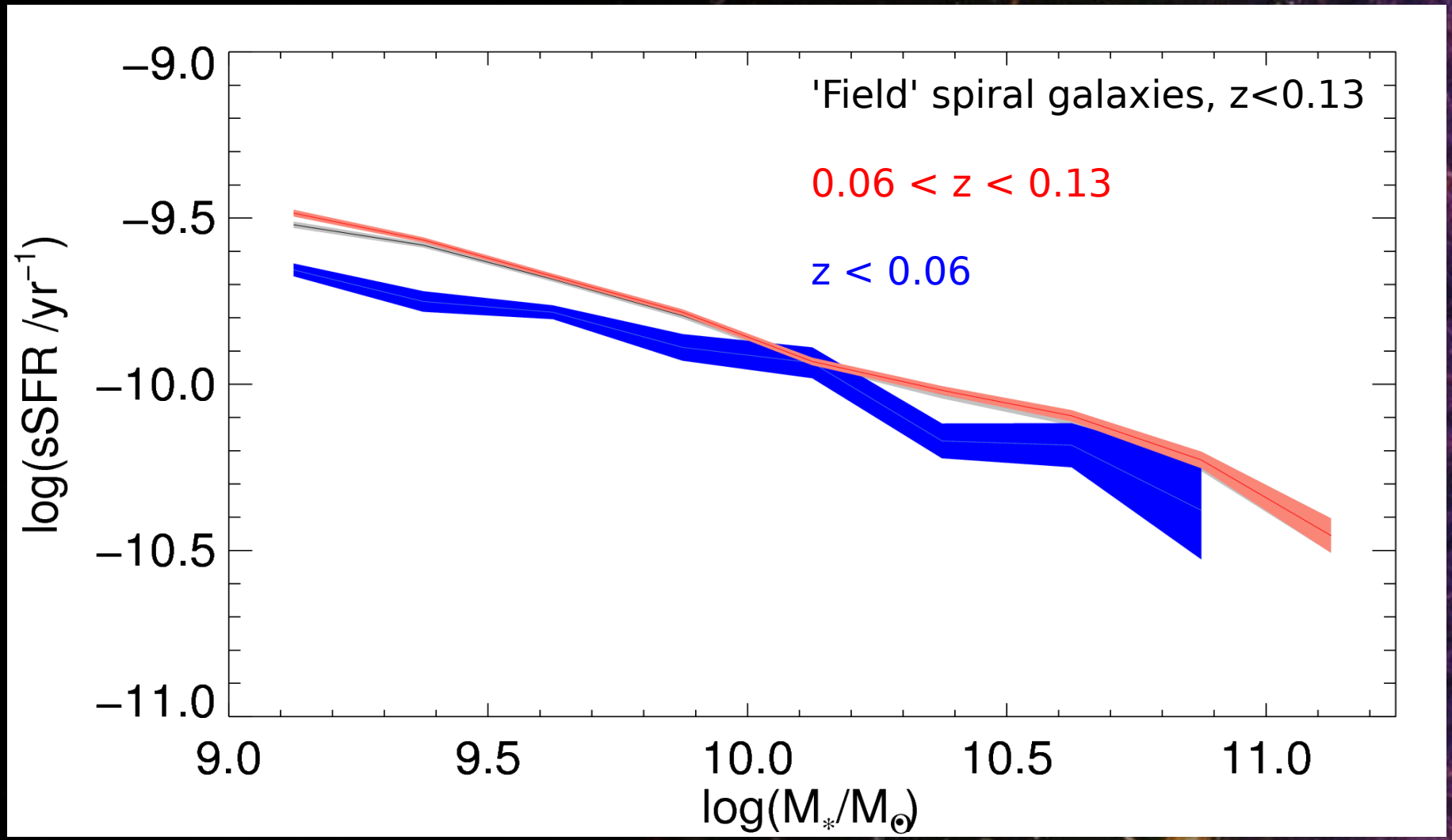
Main sequence of 'Field' spiral galaxies: Evolution over $\Delta z = 0.05$



Grootes+2015a

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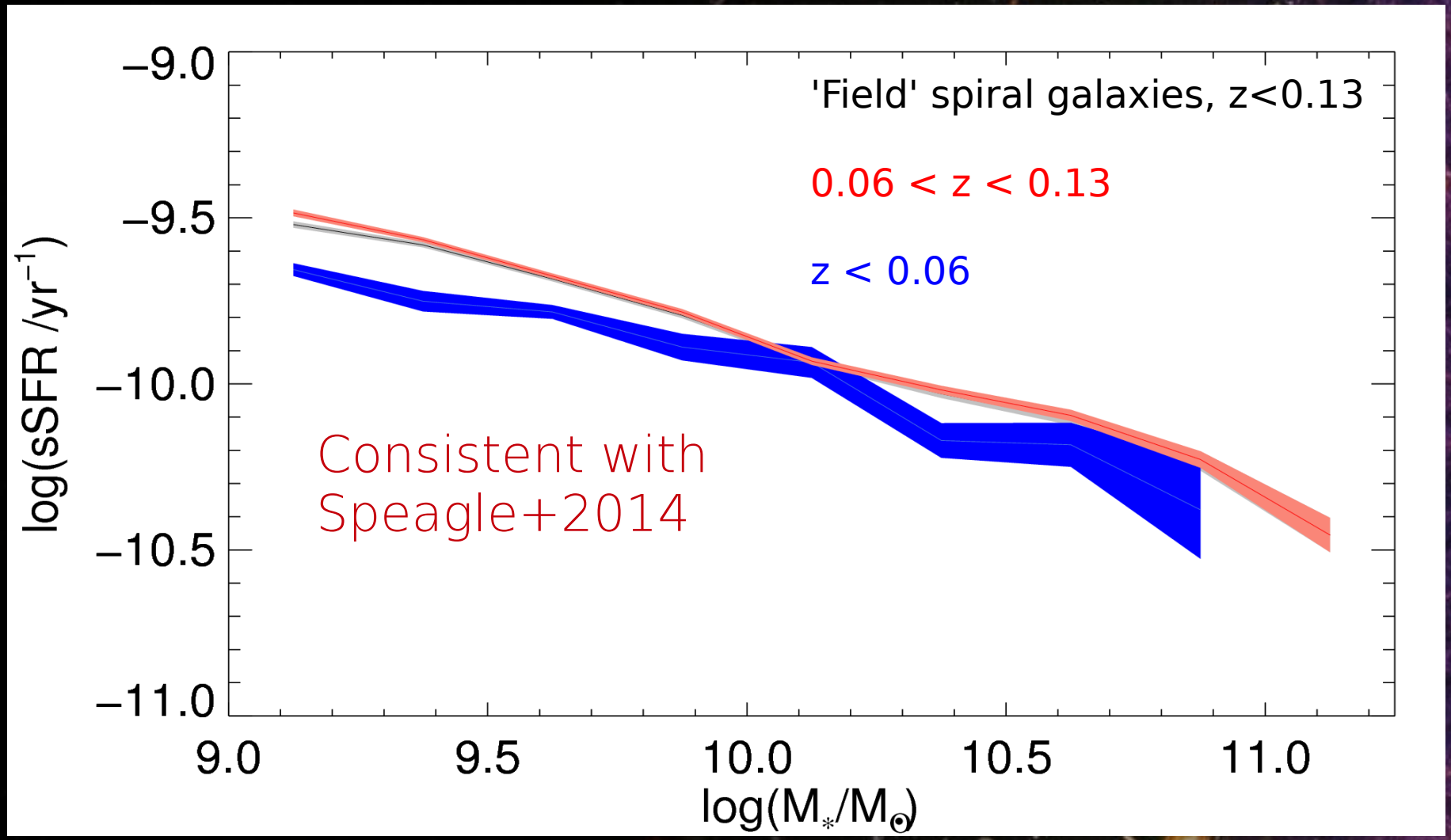
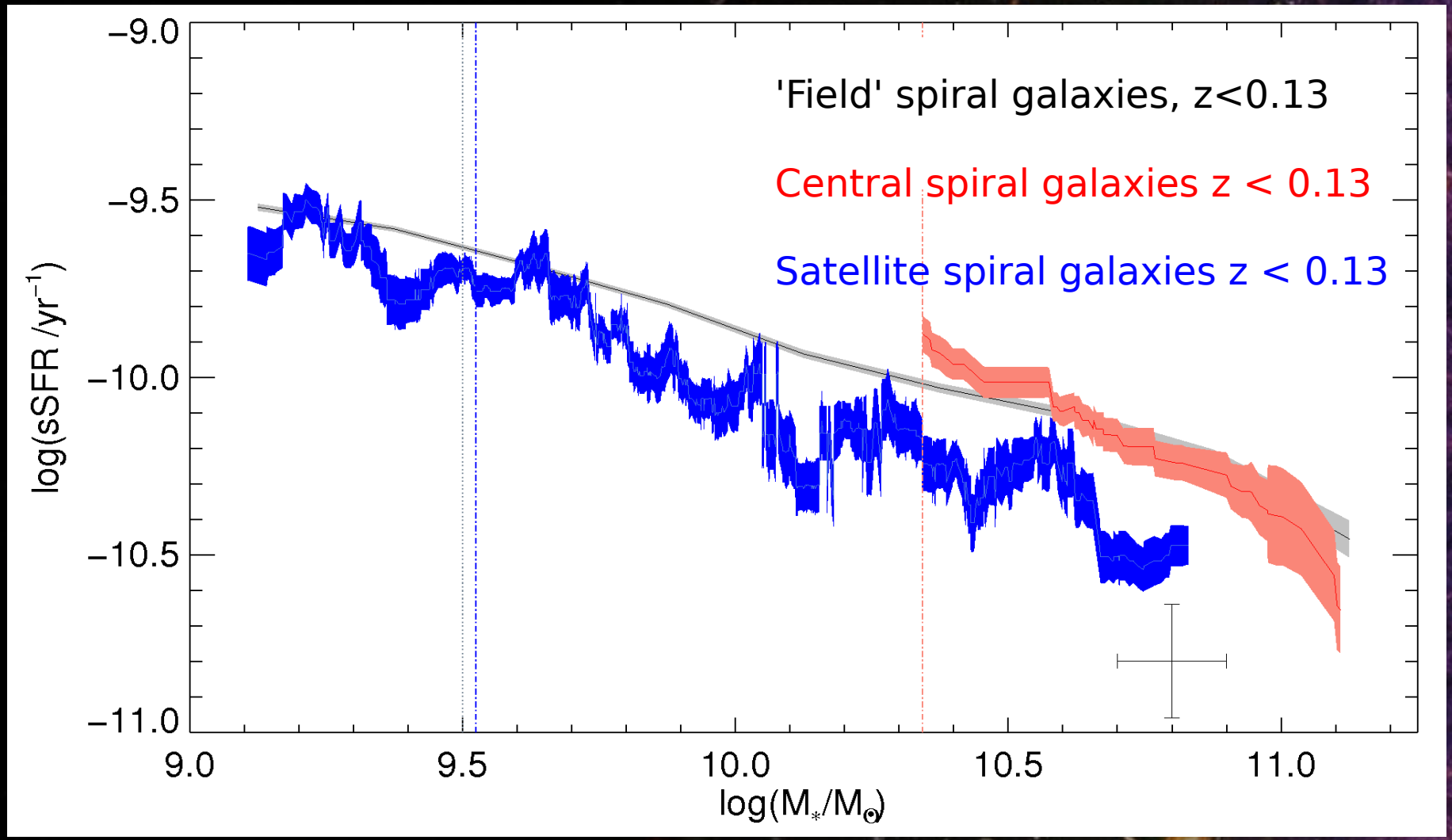


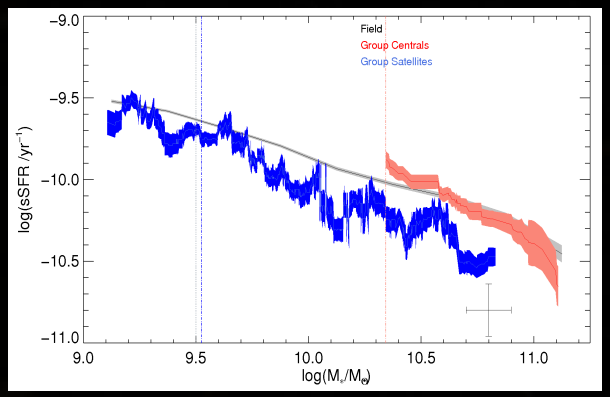
Grootes+2015a

Main sequence of group spiral galaxies: Satellites & Centrals

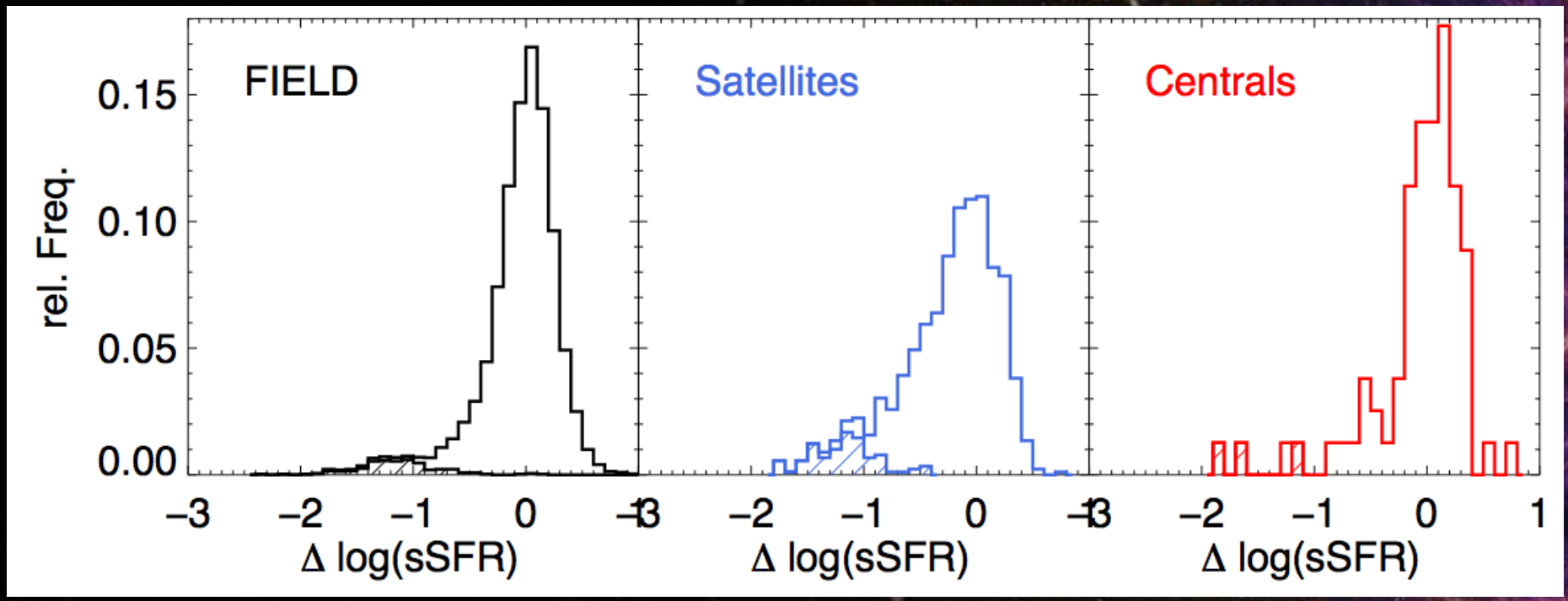


Grootes+2015a

Main sequence of group spiral galaxies: Satellites & Centrals

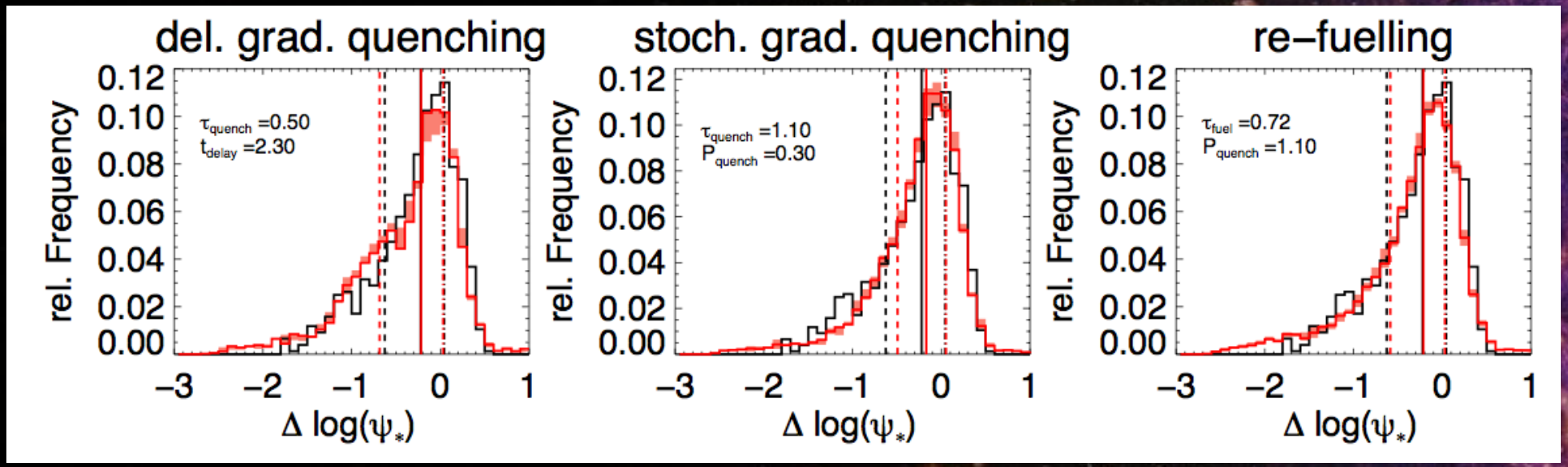


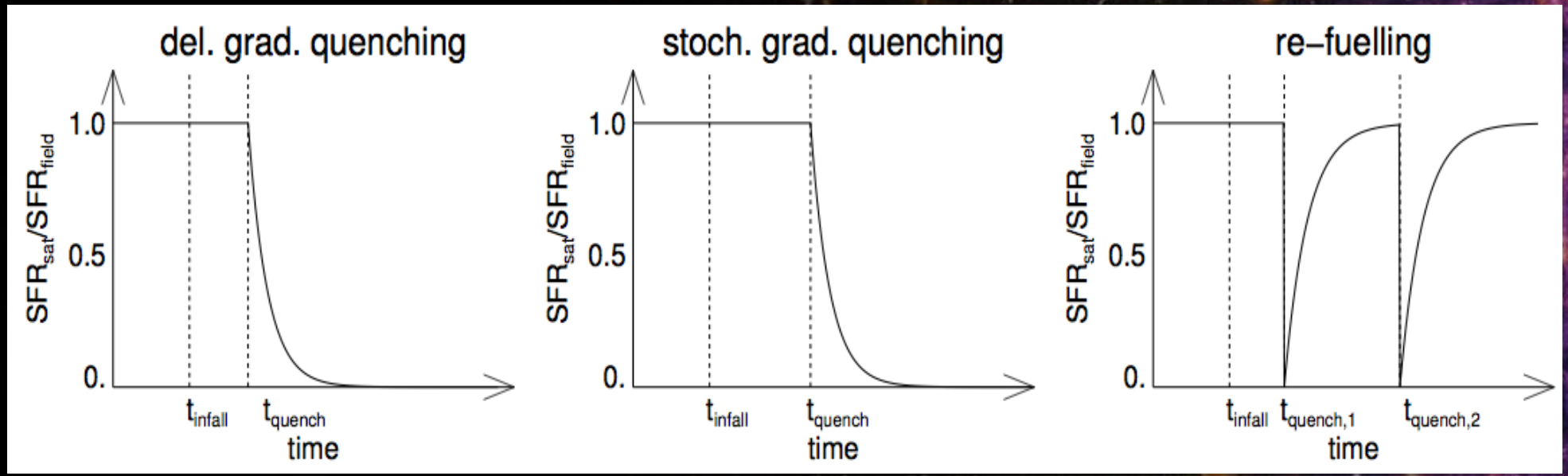
Spiral fraction only decreases by 40%



Grootes+2015a

Modelling Satellites





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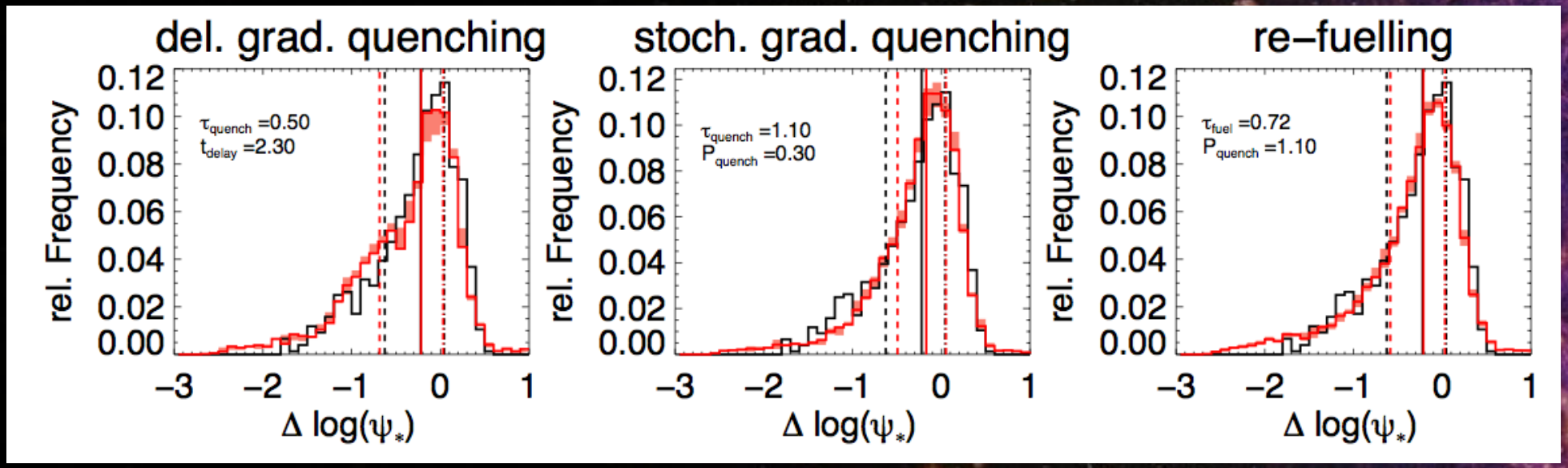


$$\dot{M}_{\rm ISM} = \dot{M}_{\rm ISM,in} - \dot{M}_{\rm ISM,out} - \Phi_*$$

$$\Phi_* = \kappa M_{\rm ISM}$$

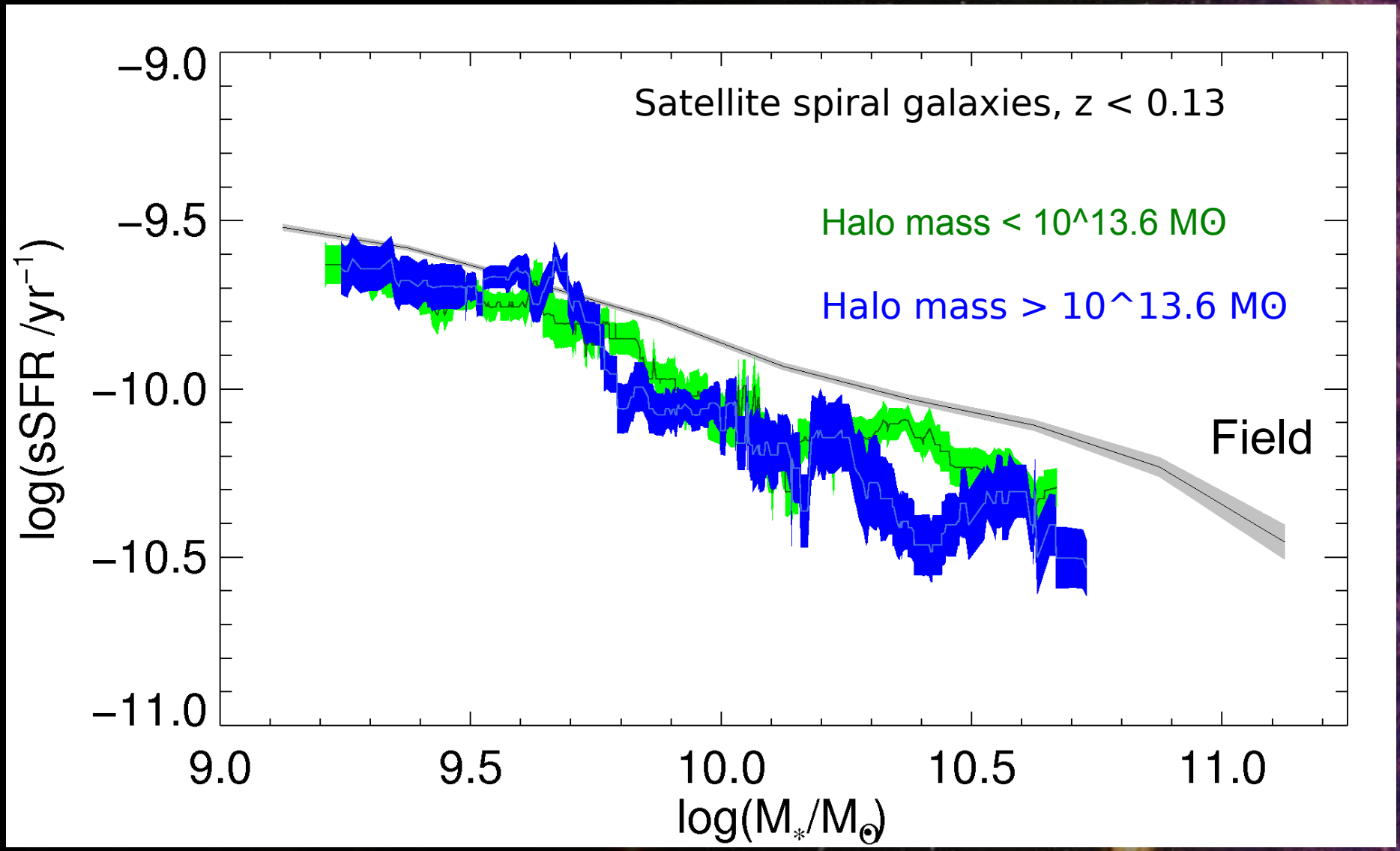
$$\dot{M}_{\rm ISM,out} = \beta M_{\rm ISM}$$

All models require significant replenishment of ISM

Depletion timescale estimates require accretion from IGM of halo

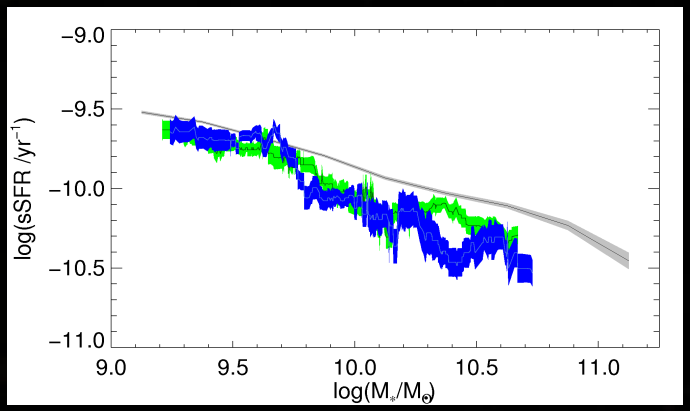
Grootes+2015a

Probing Environmental Dependencies in Detail: Halo Mass



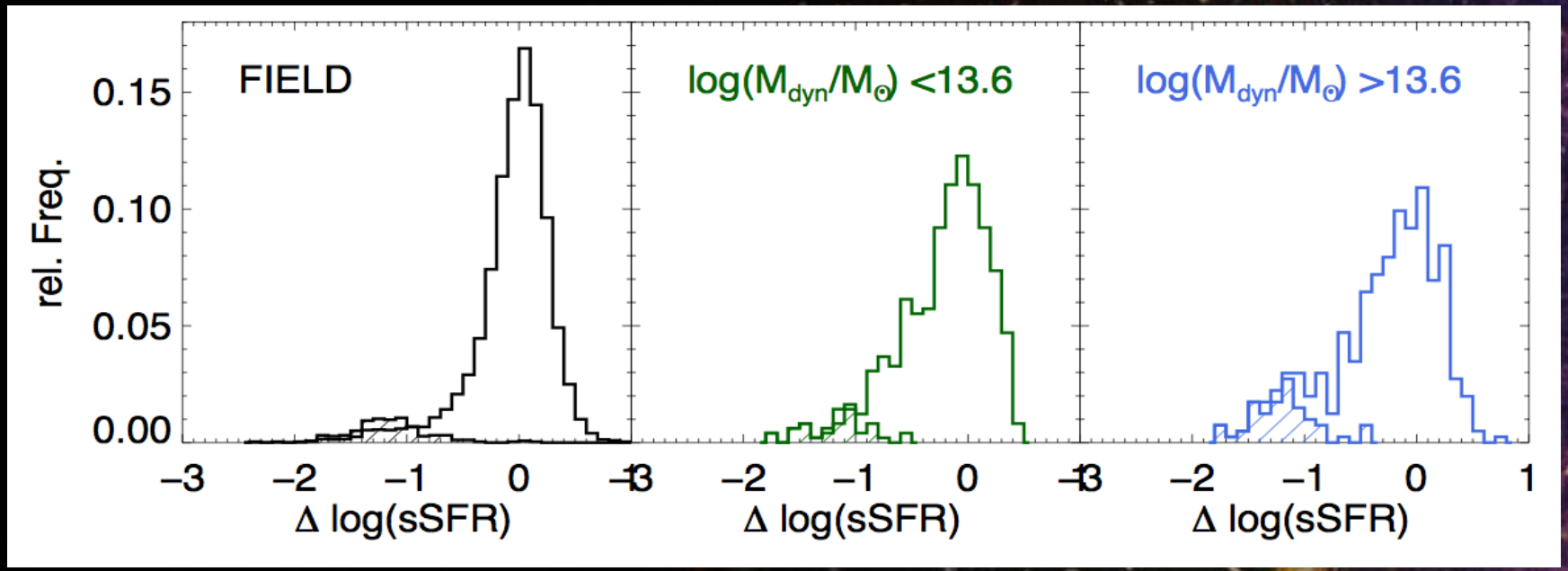
Grootes+2015b

Probing Environmental Dependencies in Detail: Halo Mass



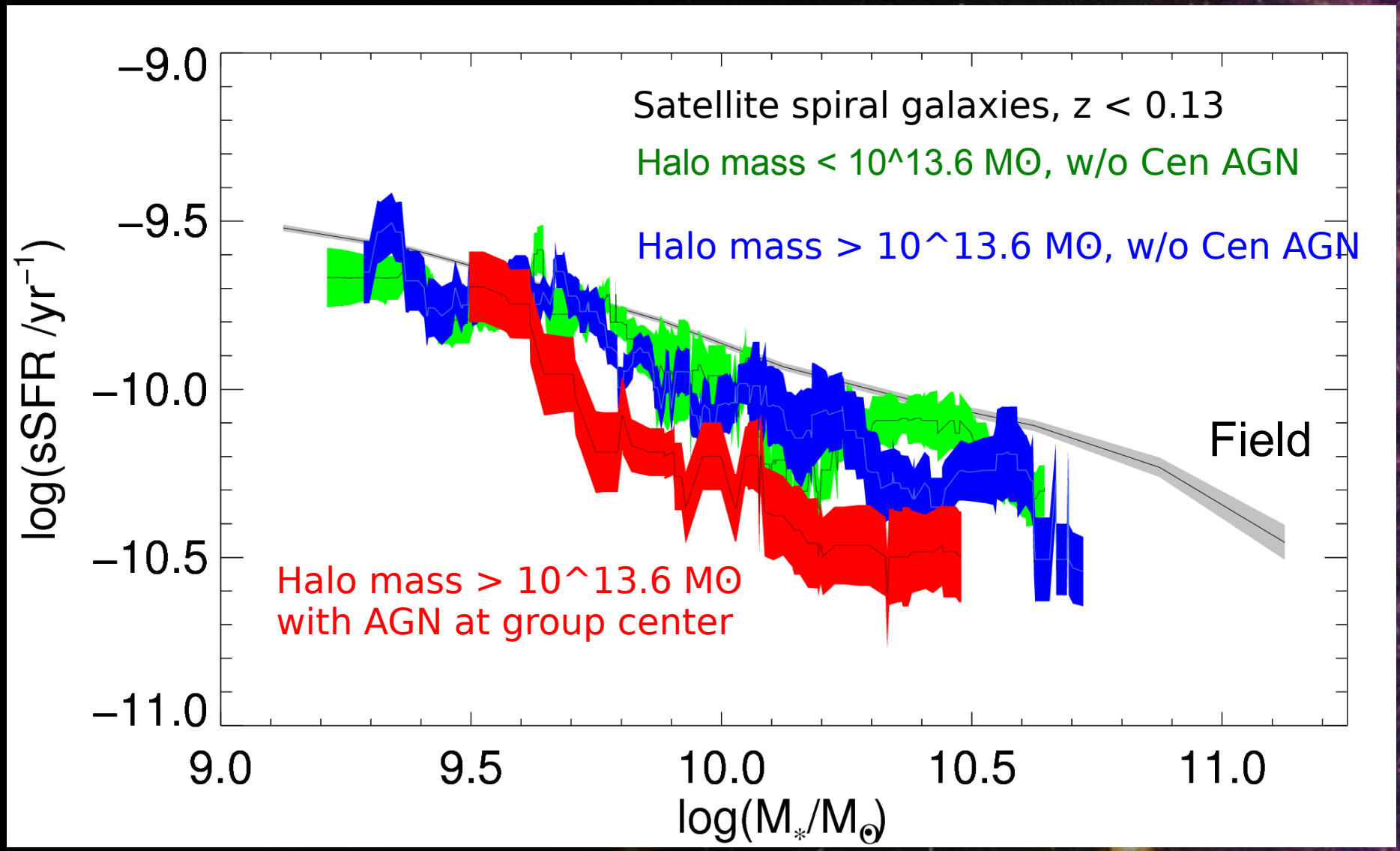
Satellite spiral galaxies, $z < 0.13$

Satellite Spiral Galaxies, $z < 0.13$



Grootes+2015b

Probing Environmental Dependencies in Detail: Group Central AGN



Grootes+2015b

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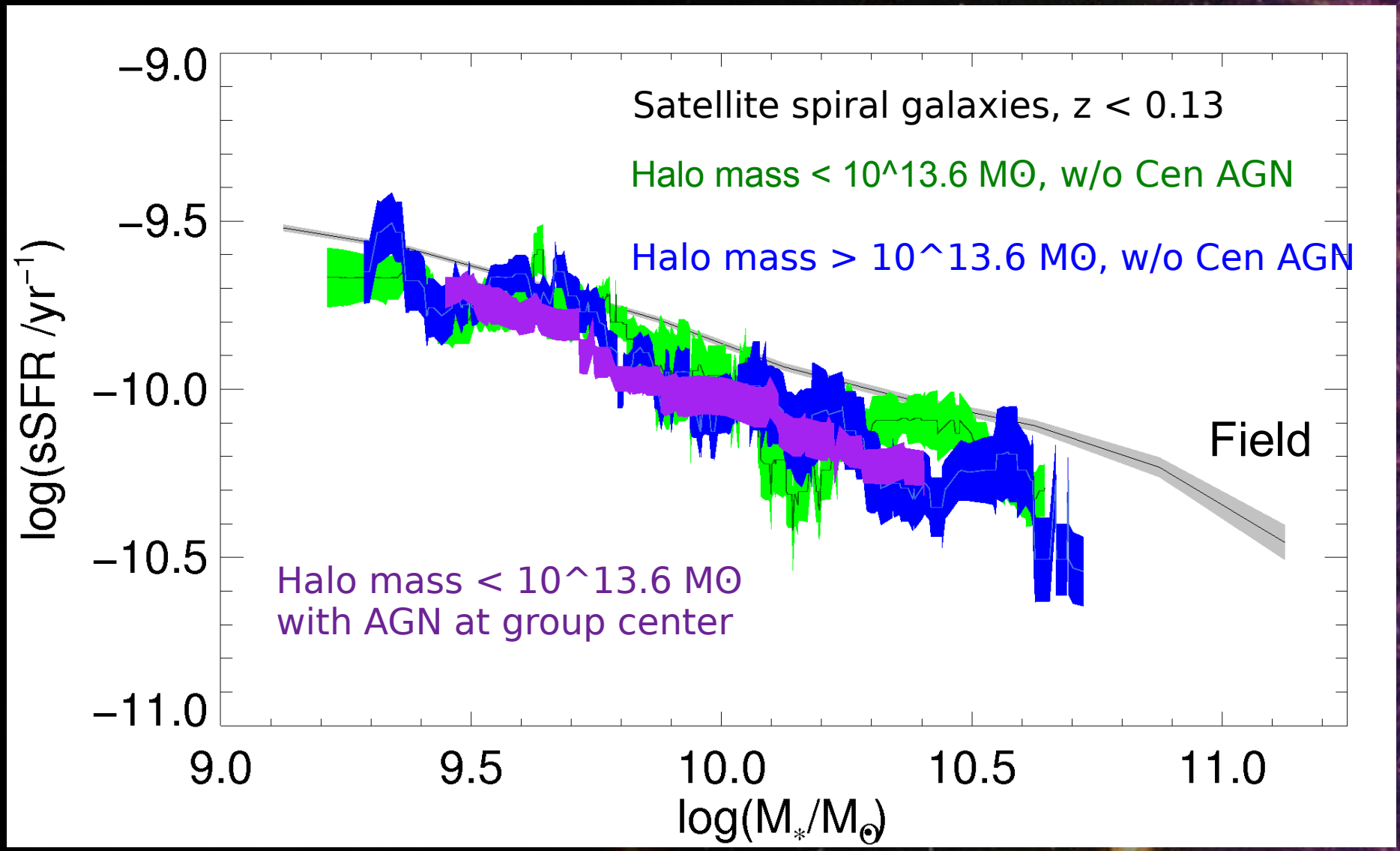
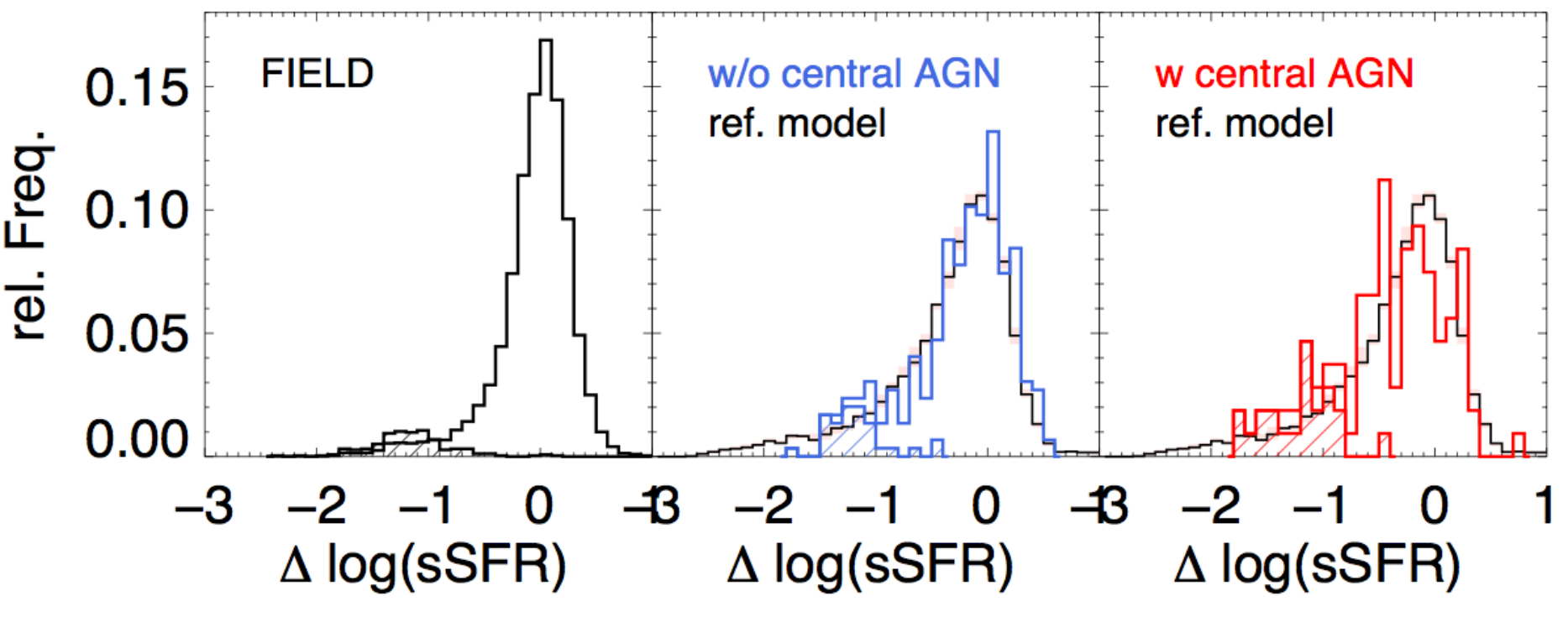


Grootes+2015b

Probing Environmental Dependencies in Detail: Group Central AGN

Satellite spiral galaxies; Halo Mass > 10^13.6 Mo



Grootes+2015b

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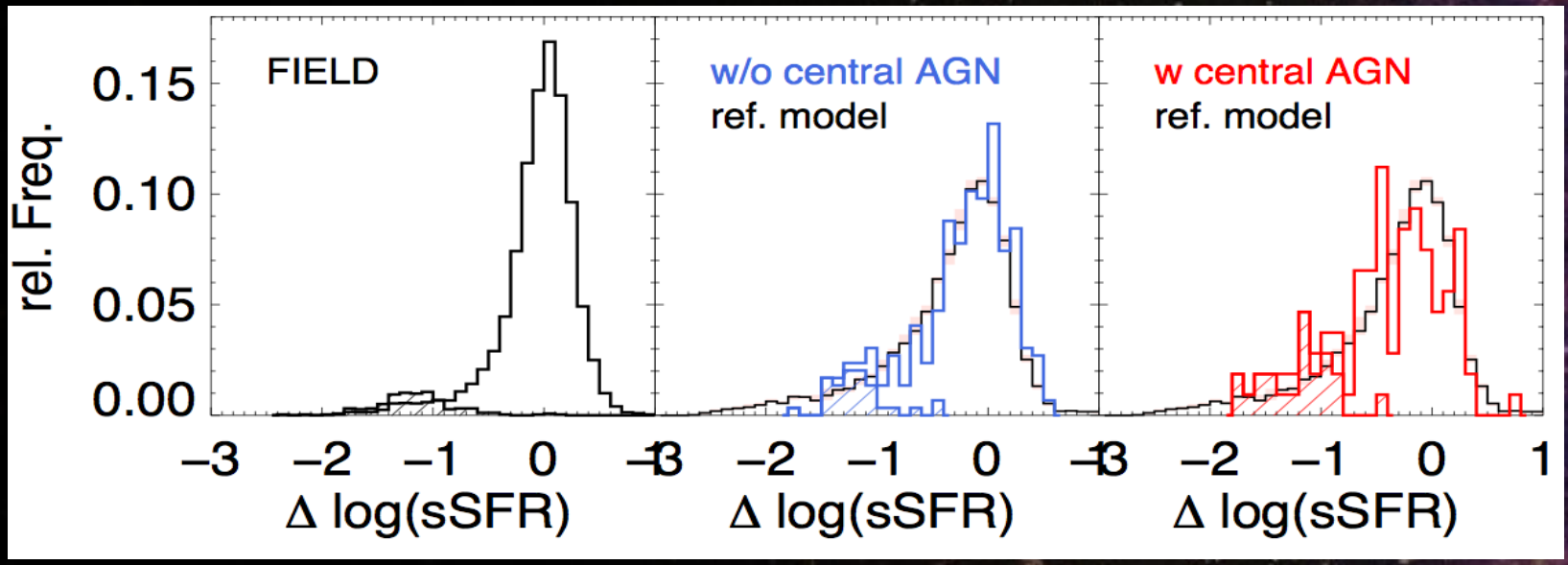

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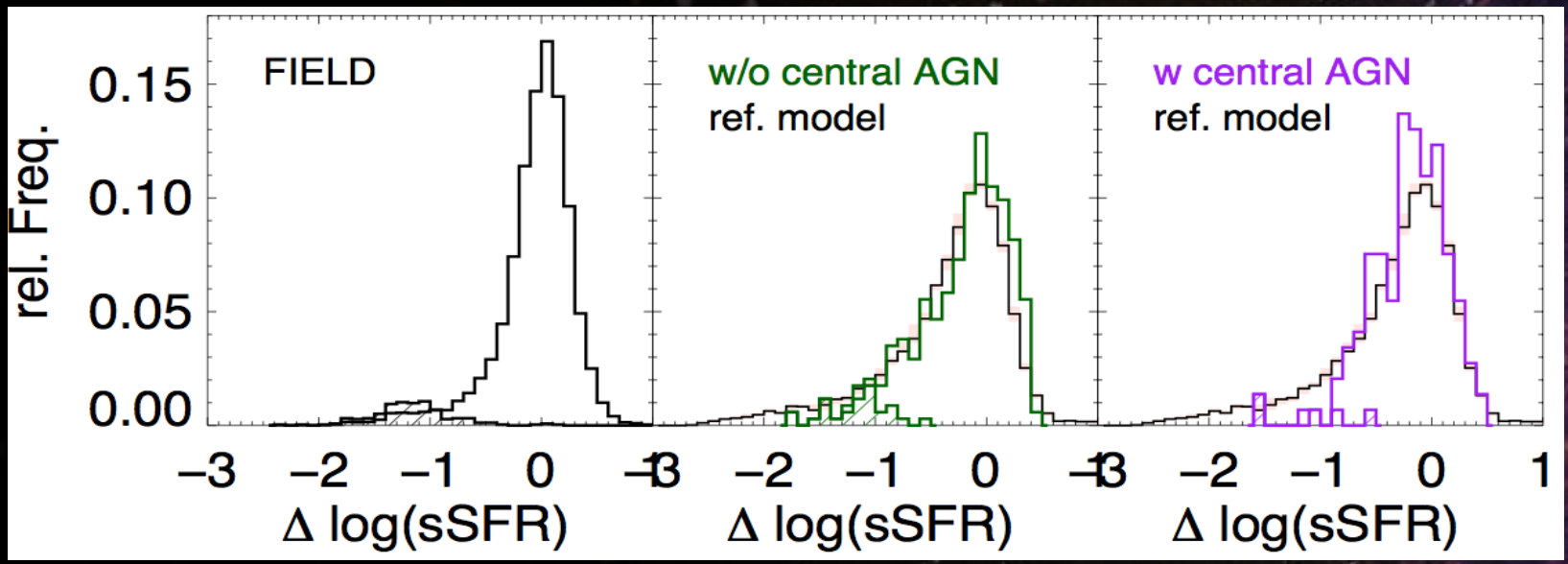


Central Spiral Galaxies: Self-regulation vs. Evolution

'Field' Galaxies are centrals

Field:

$\langle \log(M_*/M_{halo}) \rangle \approx -1.5$

Group Central:

$\langle \log(M_*/M_{halo}) \rangle \approx -2.1$

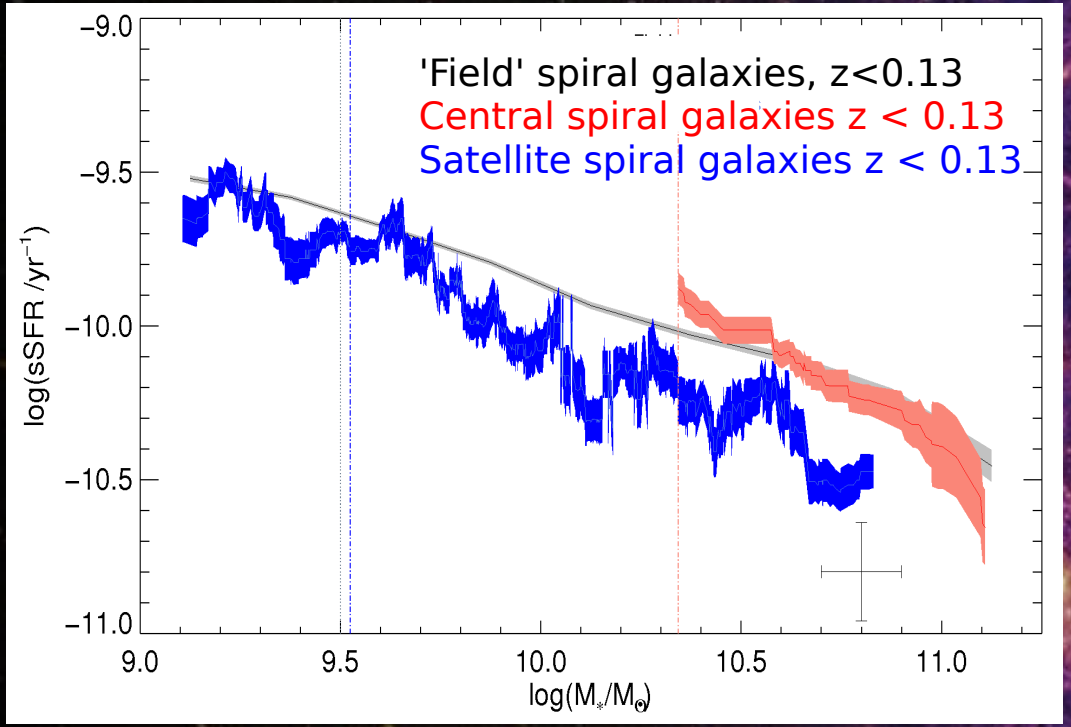
More inflowing baryons, but same sSFR → self-regulated feedback

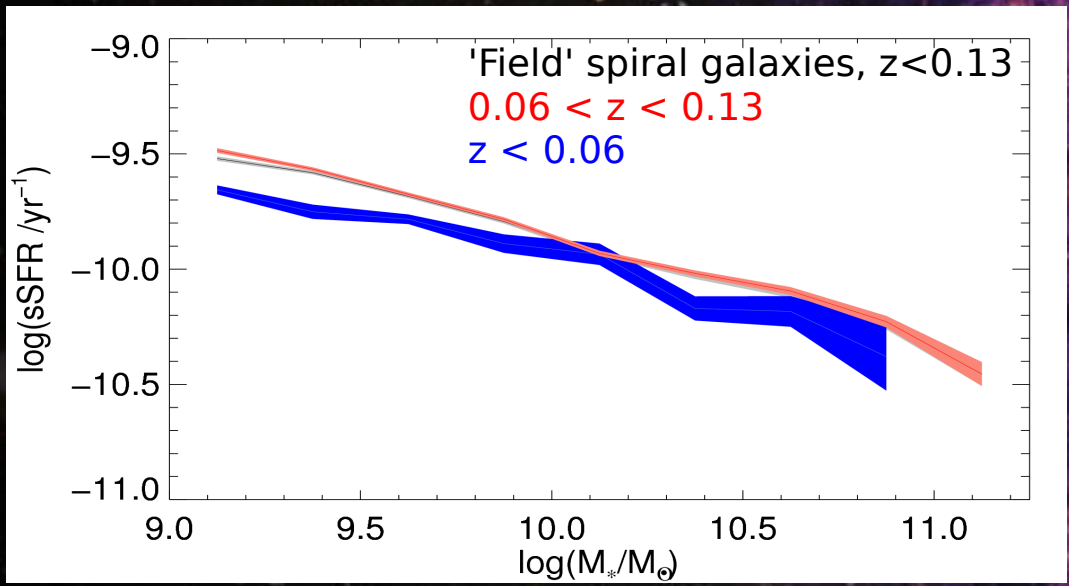
But:

Fit evolution of SFMS

thought to be determined by availability of fuel

→ Not self-regulated





Conclusions

- Gas-fuelling is on-going in satellite spiral galaxies. Accretion from gas in group halo (IGM).
- Gas-fuelling largely independent of environment (halo mass)
- Independence only broken for massive groups with a central AGN.
- Our picture of how gas-fuelling works (and its importance) is incomplete.
- The color density relation for galaxies is determined by morphological mix rather than gas-fuelling
- Possible Tension between self-regulated feedback and evolution of 'Main Sequence of Star-forming Galaxies'

THANK YOU