

The EAGLE Project:

Evolution of AGNs (and other properties) in
Hydrodynamical Simulations
[www.icc.dur.ac.uk/Eagle]

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Leiden: Rob Crain, Joop Schaye
Claudio Dalla Vecchia, Ian McCarthy, Craig Booth...

+ Virgo Consortium



VIRGO



A visualization of the cosmic web, showing a complex network of filaments and nodes of matter in the universe. The colors range from blue to red, representing different physical properties or densities. The word "Overview" is centered in white text over this image.

Overview

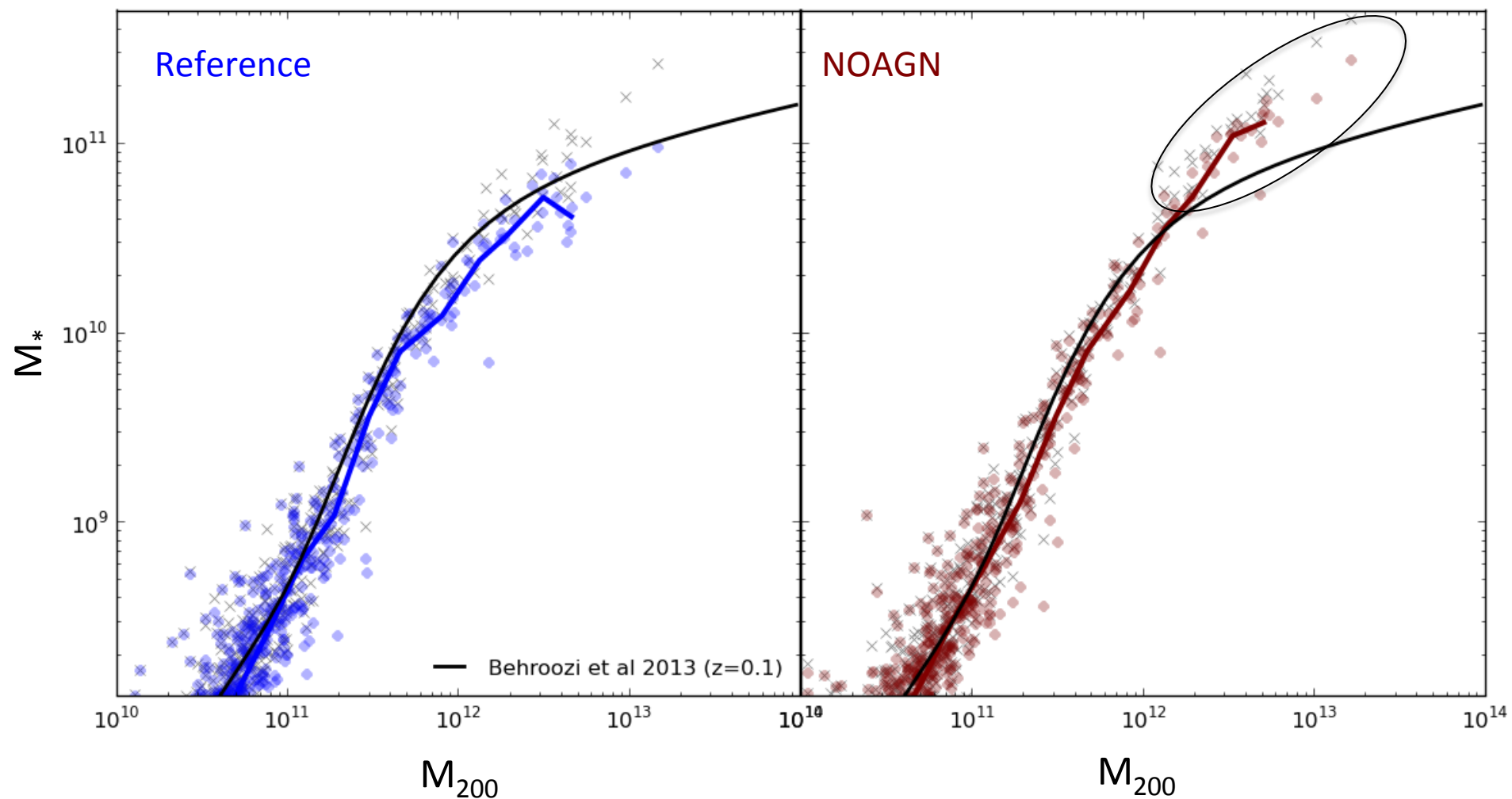
- Overview of Simulation
- Local Universe Results
- High Redshift Observation Comparison
- Black Hole Properties and Evolution
- Summary

EAGLE: Evolution and Assembly of GaLaxies and their Environments

- Hydrodynamical Simulations
- Planck Cosmology
- Resolution 10^6 solar masses, 700pc smoothing length
- 25, 50 and **100 Mpc** boxes
- Advanced subgrid physics
 - Star formation
 - Cooling
 - Chemical evolution
 - Stellar feedback -> thermal
 - AGN feedback -> ang. mom.
- Evolution to redshift 0


z = 29.810

Model Variations (25Mpc boxes)



M_{200}

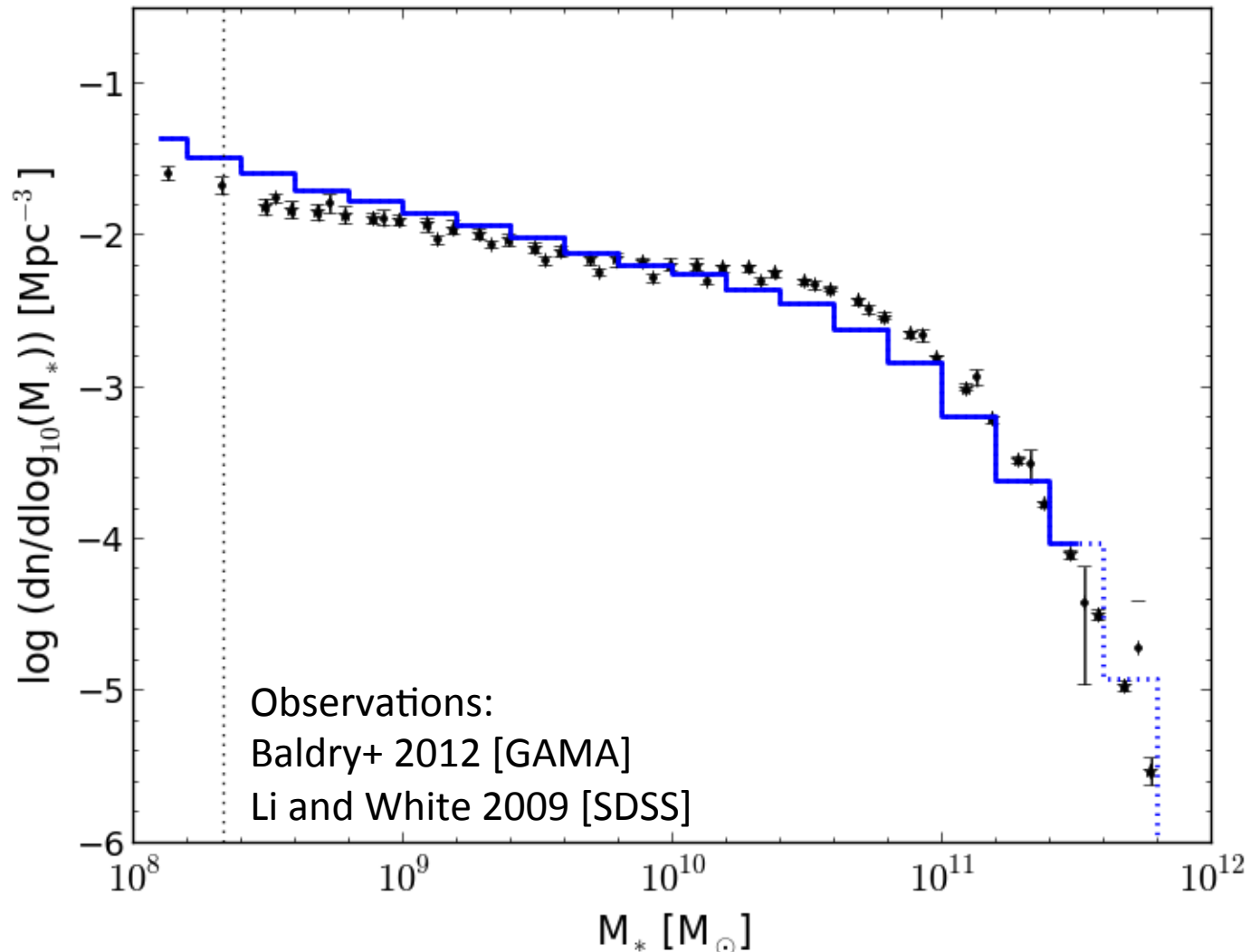
M_{200}

A visualization of the cosmic web, showing a complex network of filaments and nodes of galaxies. The colors range from blue to red, representing different physical properties like density or temperature. The title "The Local Universe" is overlaid in white text.

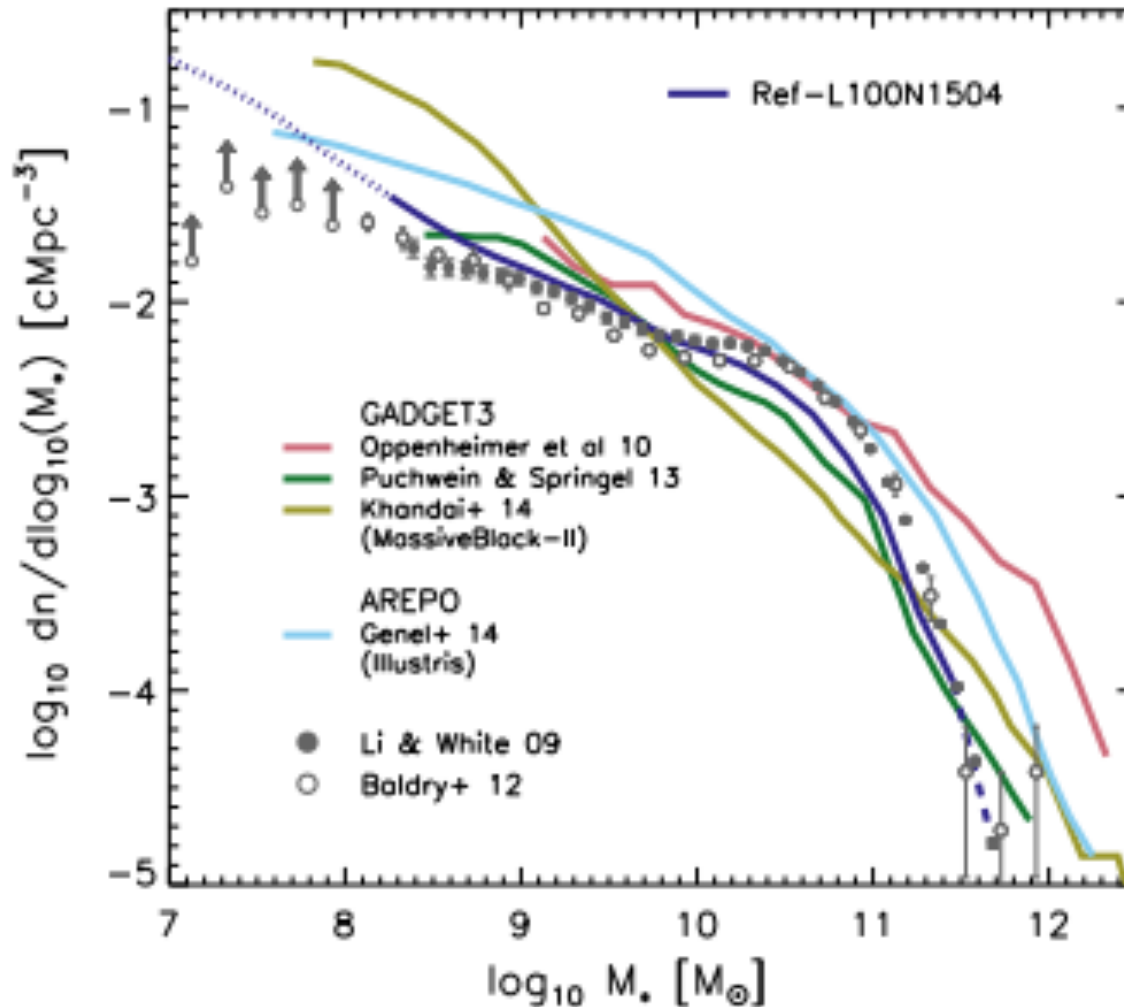
The Local Universe

What does the galaxy population look like?

The Local Universe: Galaxy Stellar Mass Function

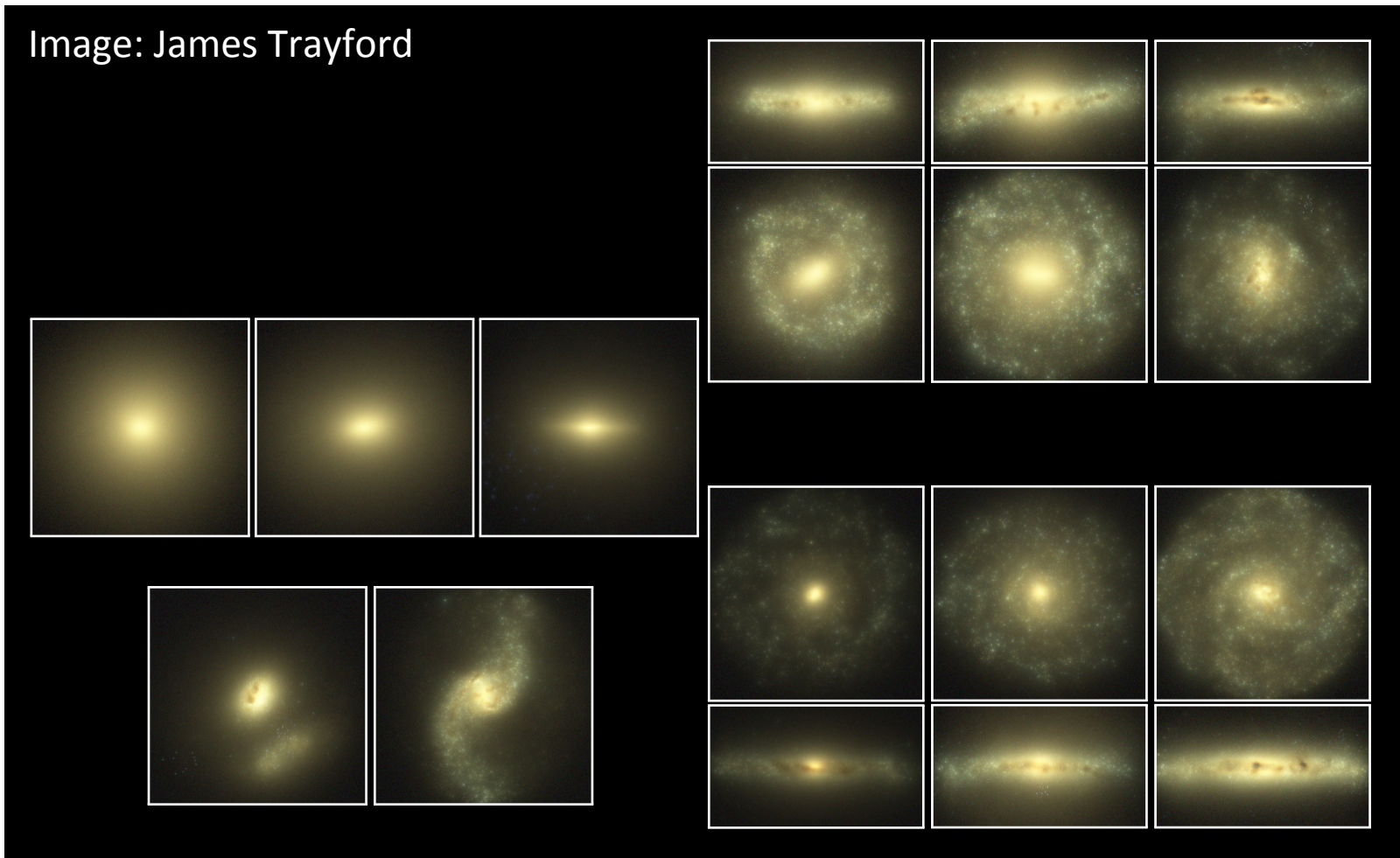


The Local Universe: Galaxy Stellar Mass Function



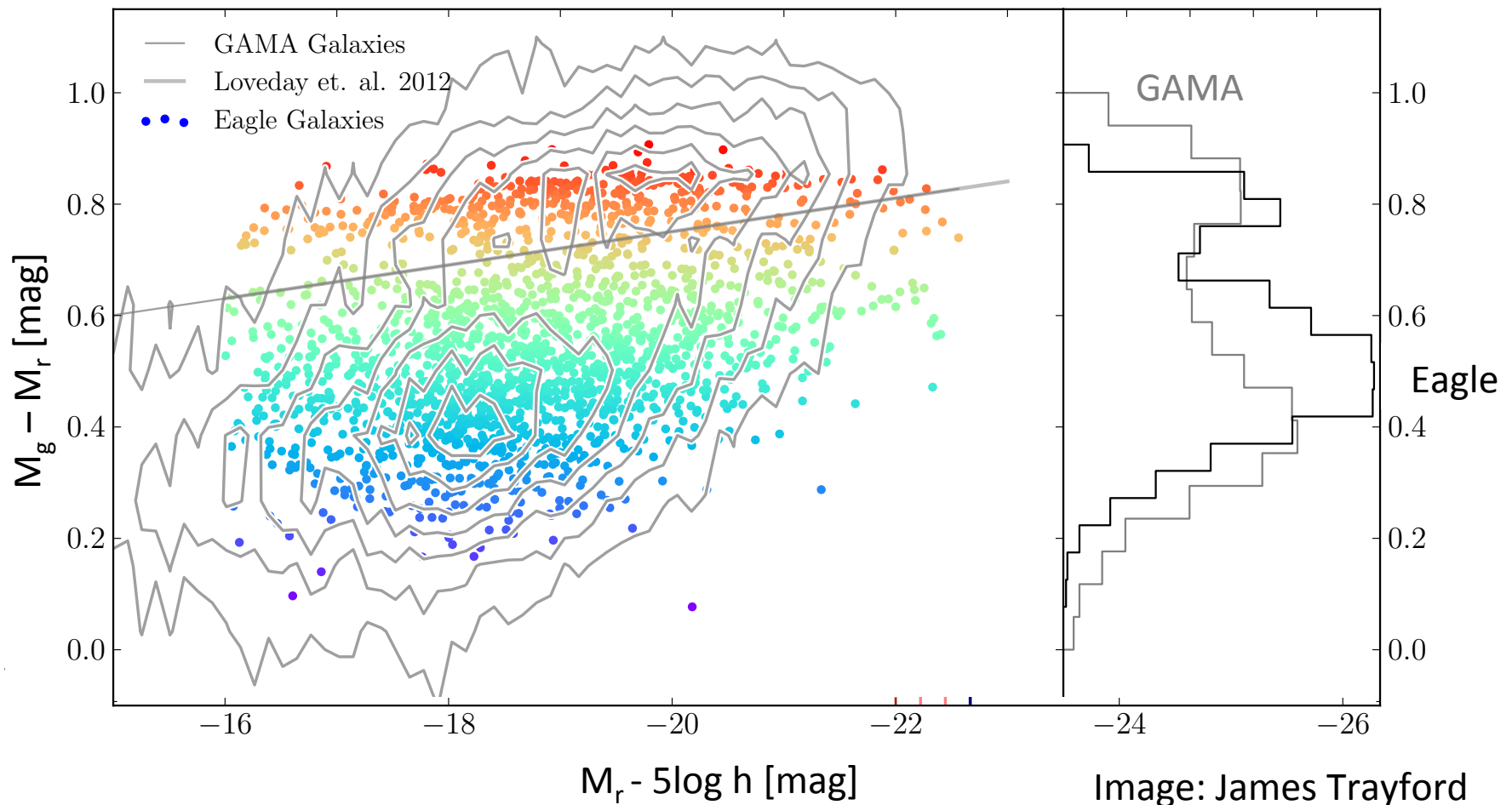
EAGLE: Evolution and Assembly of GaLaxies and their Environments

Image: James Trayford



The Eagle Simulations: Michelle Furlong

The Local Universe: Star Formation Rates

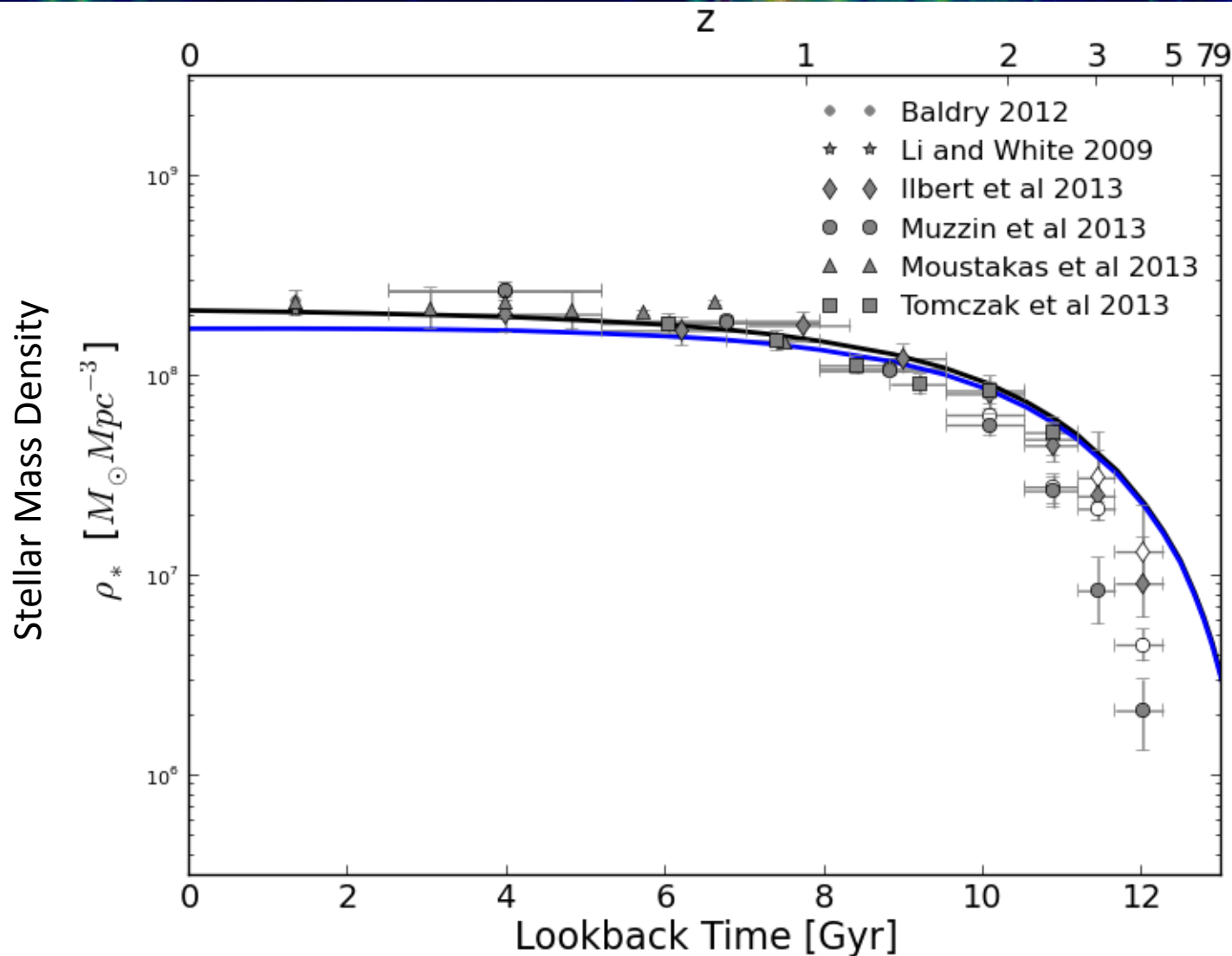


A visualization of the cosmic web, showing a complex network of filaments and clusters of galaxies. The filaments are colored in shades of blue, green, and yellow, while the clusters are more prominent in red and orange. The background is a deep blue.

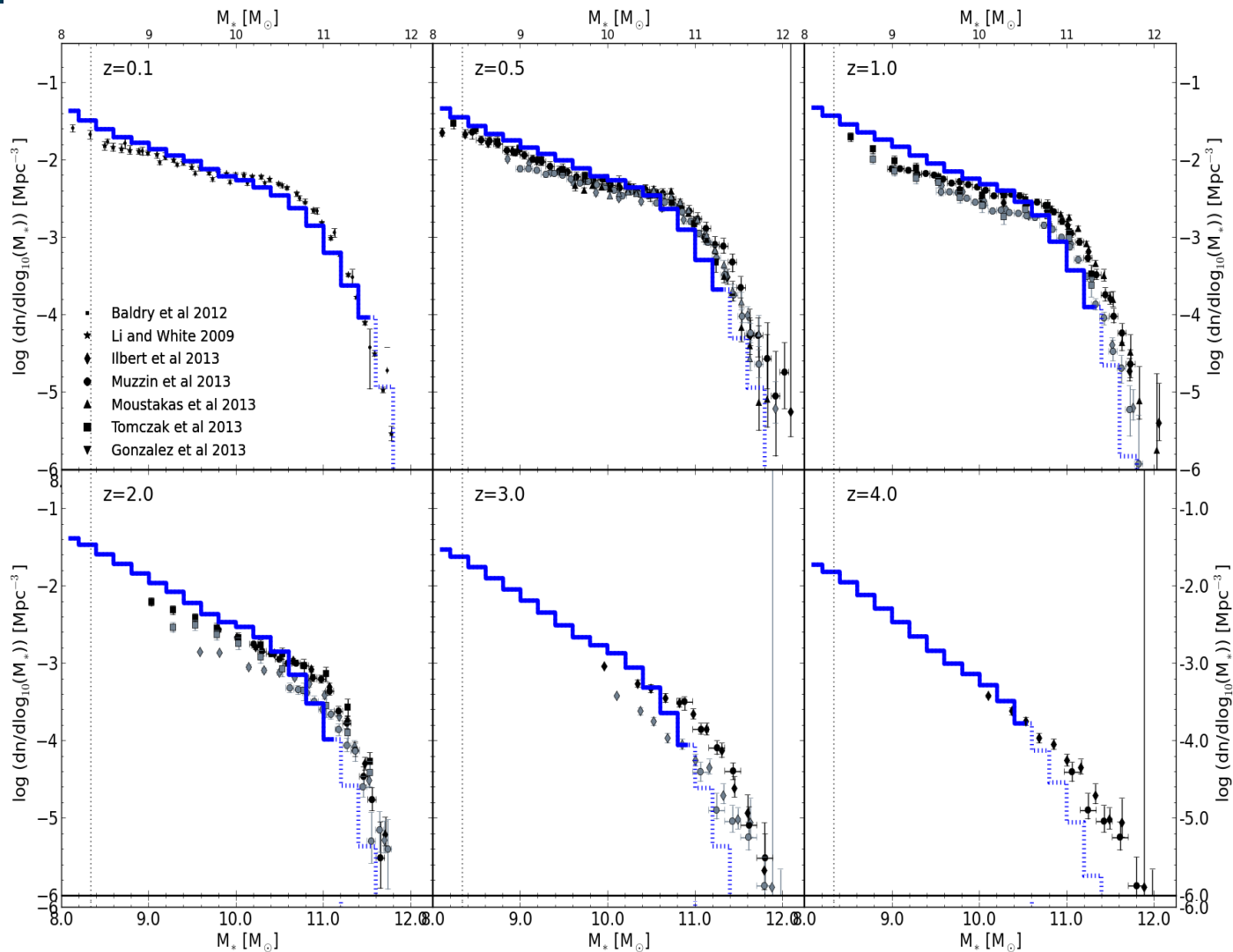
Evolution of Galaxy Properties

Going beyond the local Universe.....

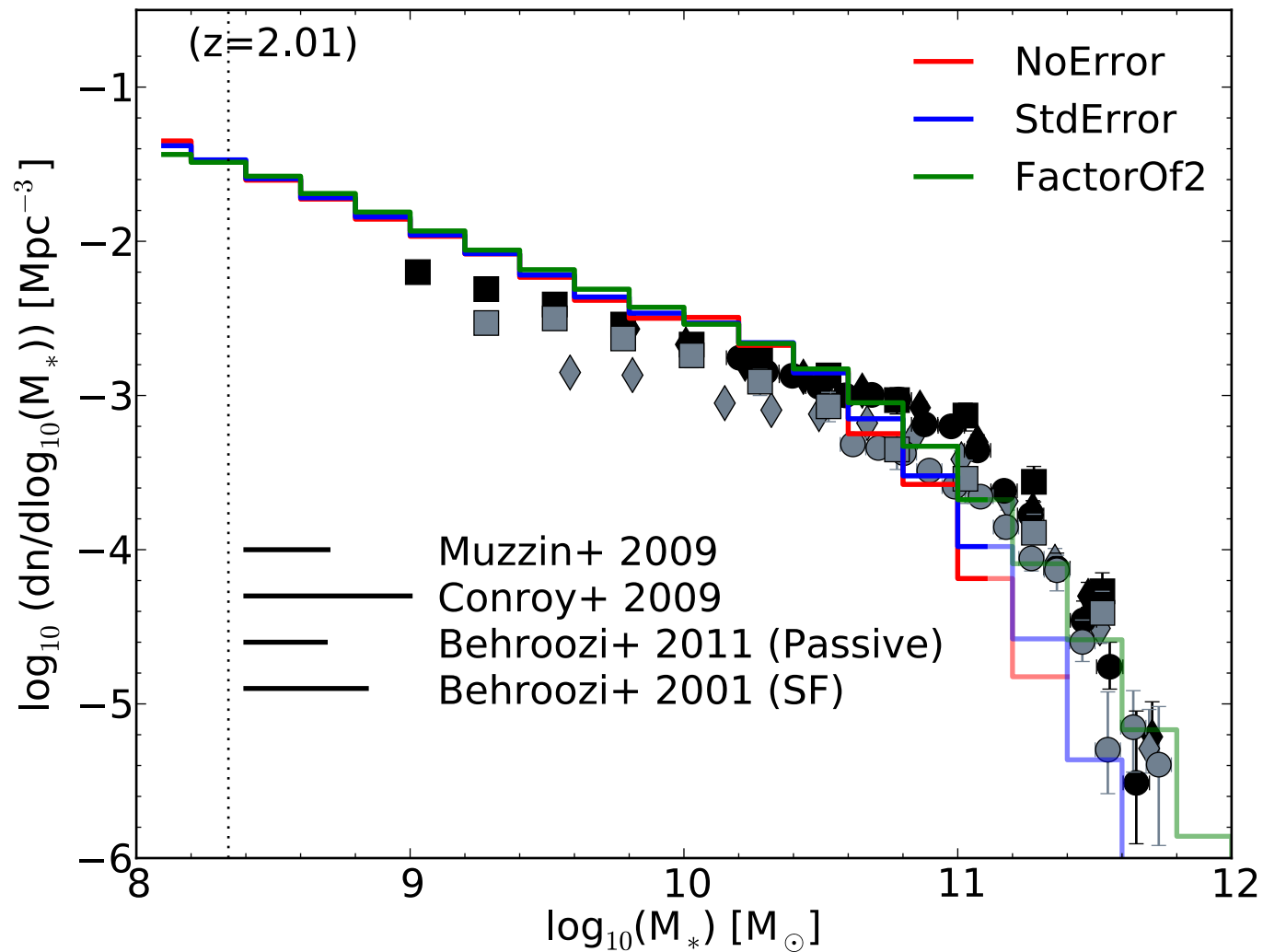
Evolution of Galaxy Properties: Stellar Mass



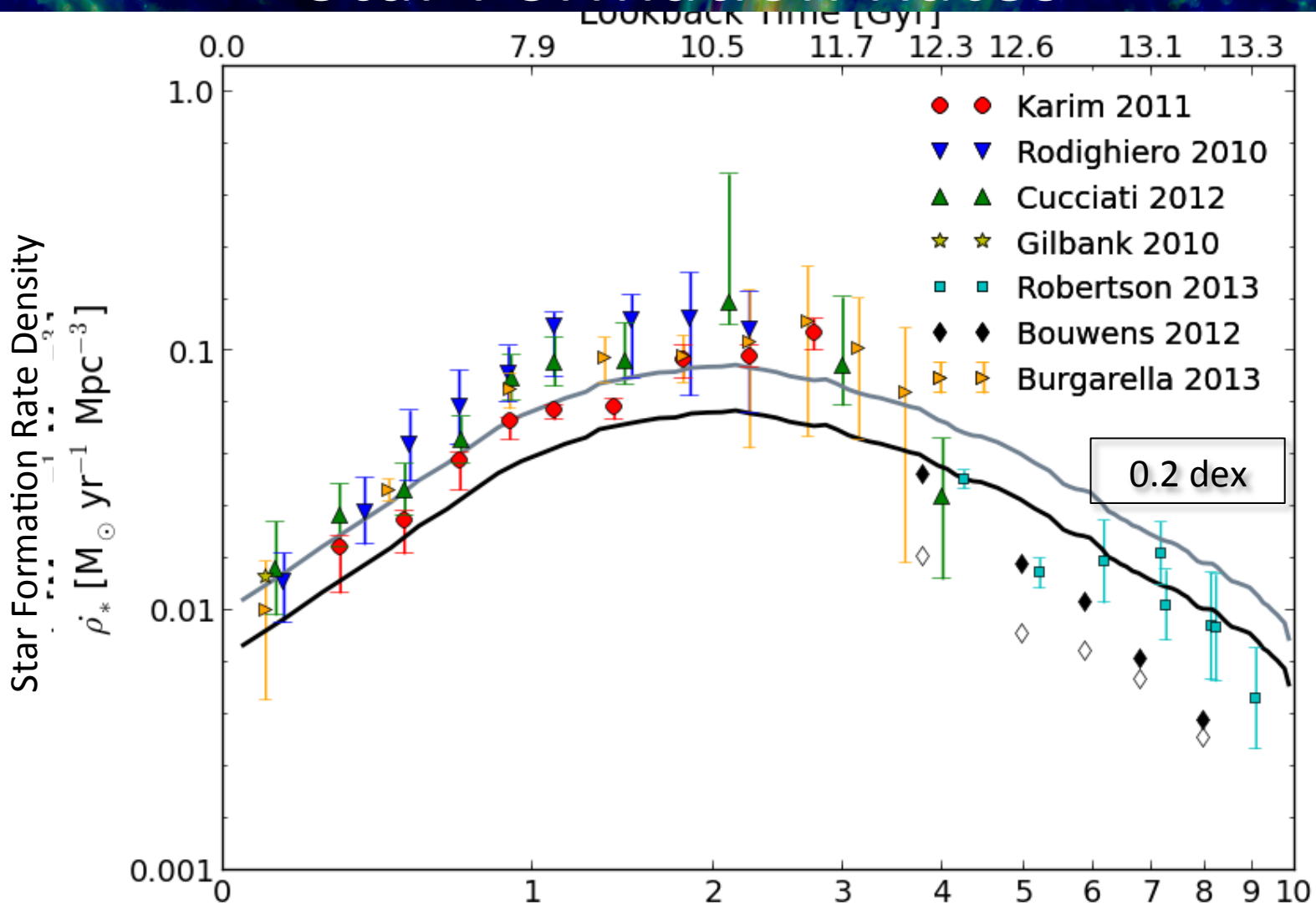
Evolution of Galaxy Properties: Galaxy Stellar Mass Function



Evolution of Galaxy Properties: Stellar Mass



Evolution of Galaxy Properties: Star Formation Rates



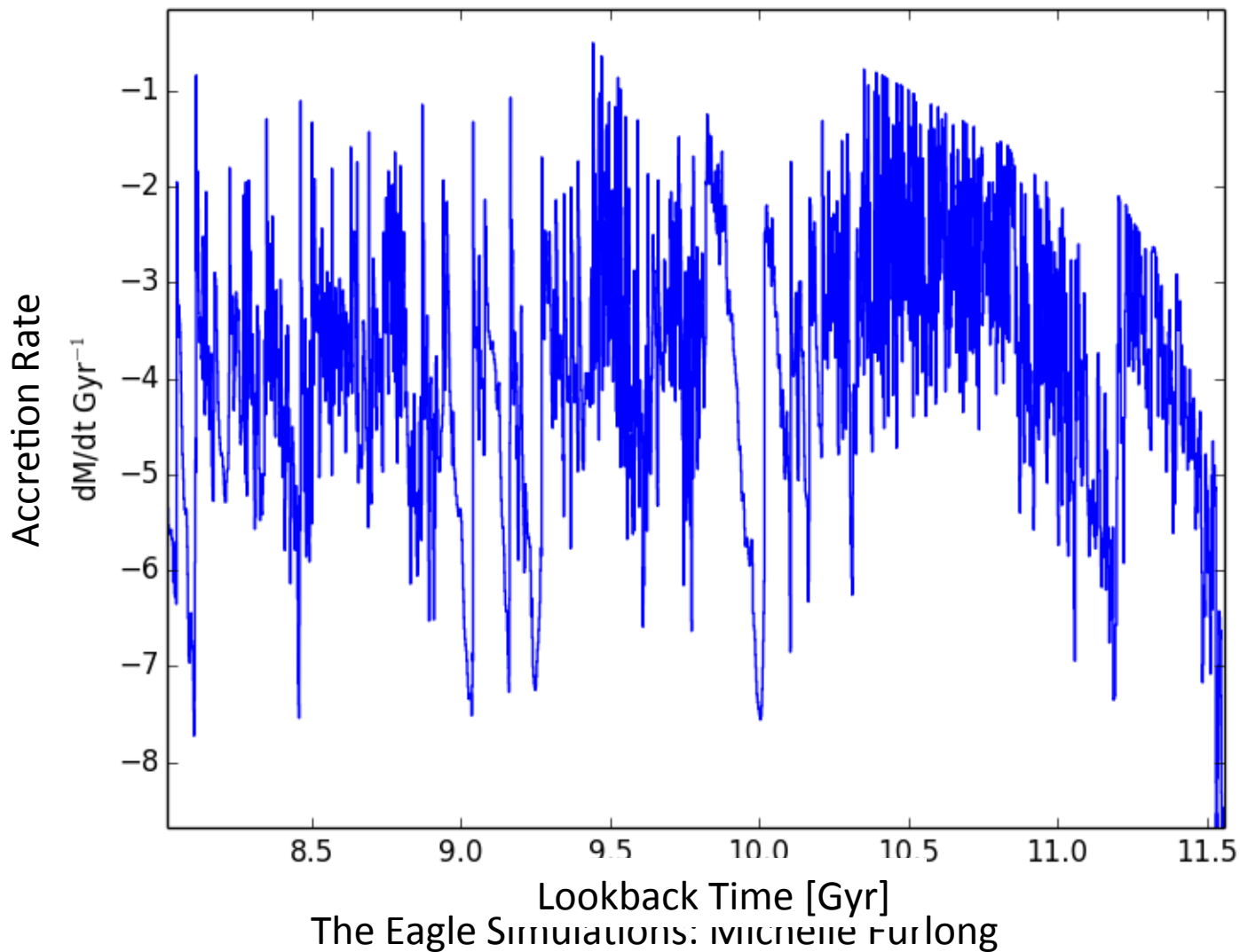
A visualization of the cosmic web, showing a complex network of filaments and nodes of matter. The colors range from blue (low density) to red and yellow (high density), with bright spots indicating galaxy clusters and individual galaxies.

AGN Luminosity Evolution

- Confidence in galaxy properties in the simulation as a function of redshift
- What about the black hole properties?
- (See Schaye+ 2014 for BH scaling relations)

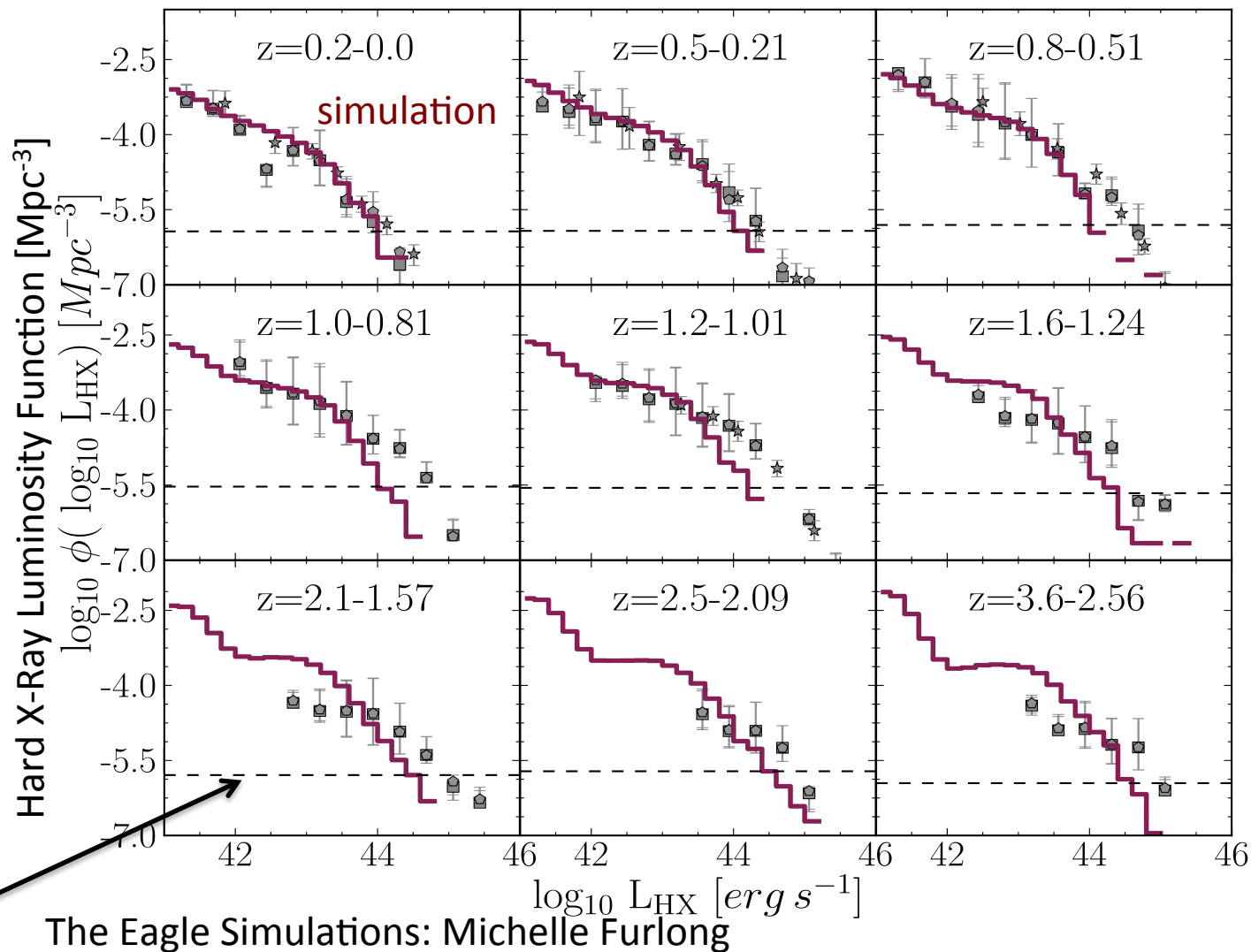
Work by Yetli Rosas-Guevara

Black Hole Variability



Hard X-Rays

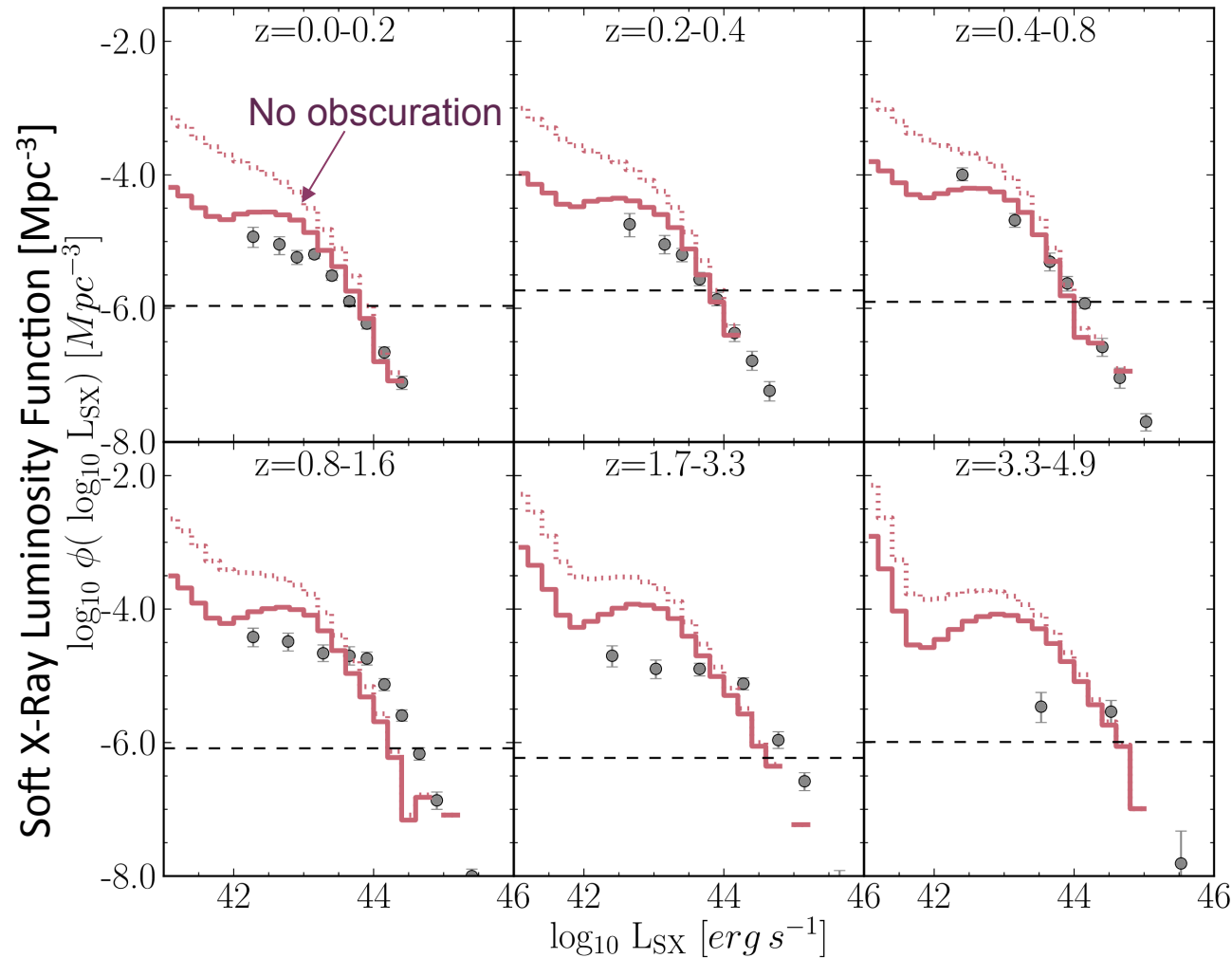
- Marconi et al 2004 to get hard x-ray luminosity
- Observations: Aird et al 2010 and Ueda et al 2003
- The evolution of HXLF is in good agreement with data at $z < 1.5$.



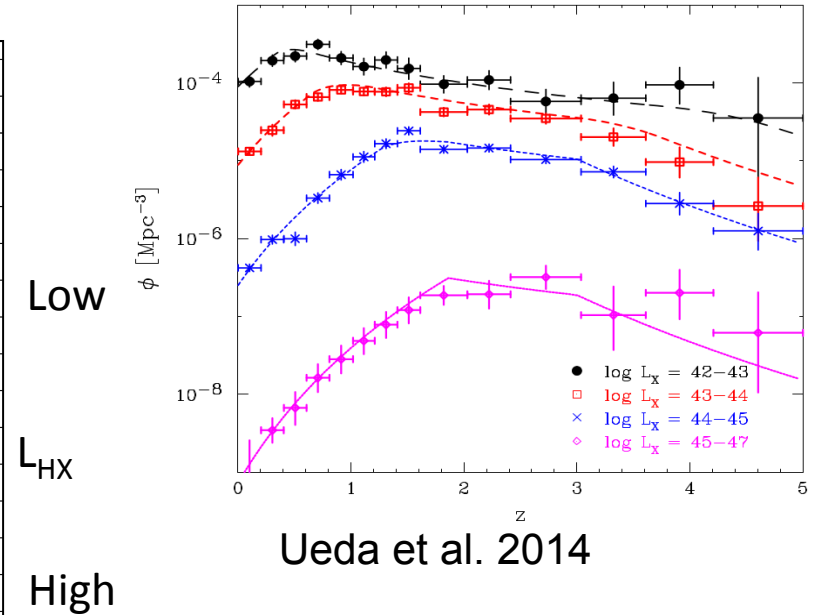
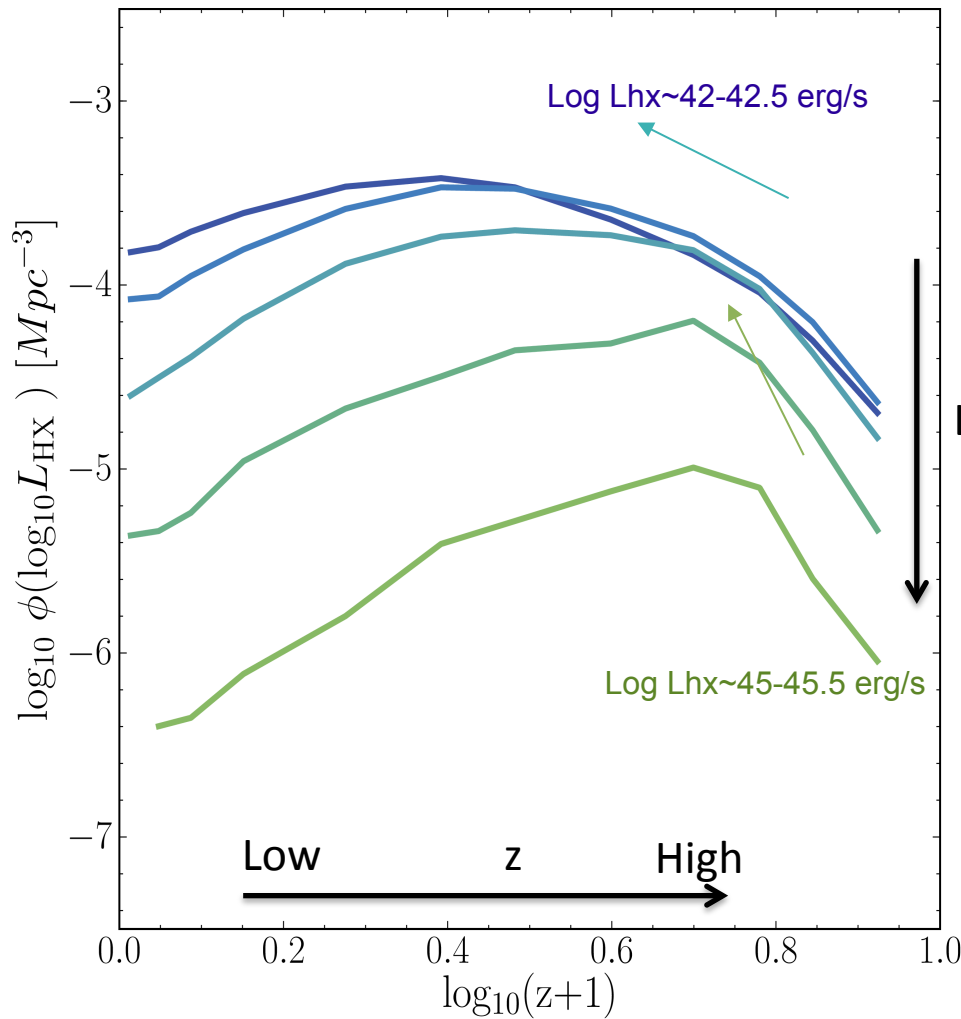
< 10 objects

Soft X-Rays

- Marconi et al 2004 to get soft x-ray luminosity
- Obscuration fraction from Hasinger+ 08
- Observations: Hasinger+ 05
- Good agreement with observations when obscuration is accounted for.



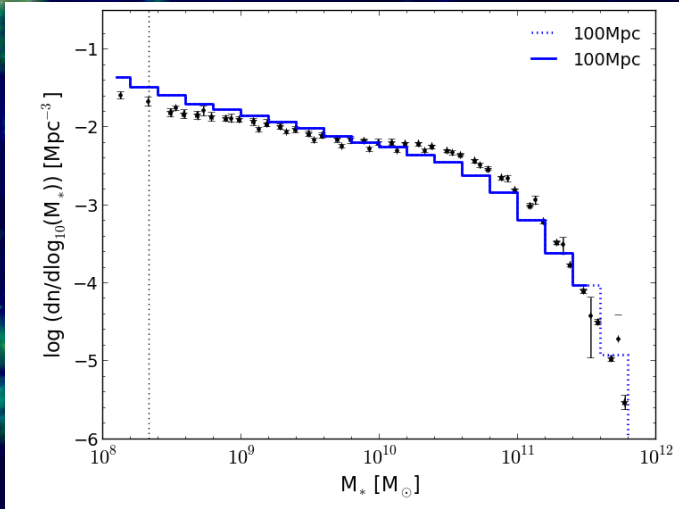
Downsizing



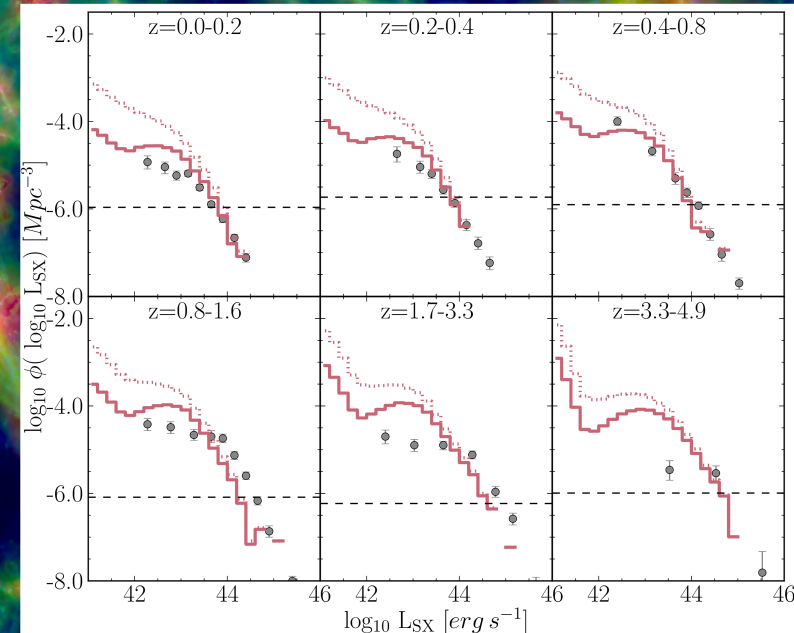
Ueda et al. 2014

Simulation shows similar evolution of the space density of AGNs – peak moves to lower redshift for lower L_{HX}

Conclusions



- Reproduce local Universe galaxy population
- Reasonable evolution of galaxy and AGN properties
- For more info: [arXiv:1407.7040](https://arxiv.org/abs/1407.7040) and www.icc.dur.ac.uk/Eagle



James Trayford

The Eagle Simulations: Michelle Furlong