Galaxy-evolution science with integral-field spectroscopy at Keck/TMT

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Galaxy evolution studies in the era of large IFU surveys

- **SDSS-IV/MaNGA** will observe **10^4 galaxies**:
  - at **1-2 kpc** spatial resolution, **0.36-1.0 μm @ R~2k**
  - over a field-of-view matched to **1.5-2.5 R_{eff}**, and
  - allowing for stellar population modeling, nebular gas emission-line diagnostics, and ionized gas and stellar kinematics

- Among the primary gains of MaNGA over existing/ ongoing galaxy evolution surveys are:
  - **Integral-field**: Uses IFUs, instead of single-fiber spectroscopy
  - **Sample size**: a factor of at least 3 increase in sample sized compared to other IFU-based surveys

Cheung et al. (2016)

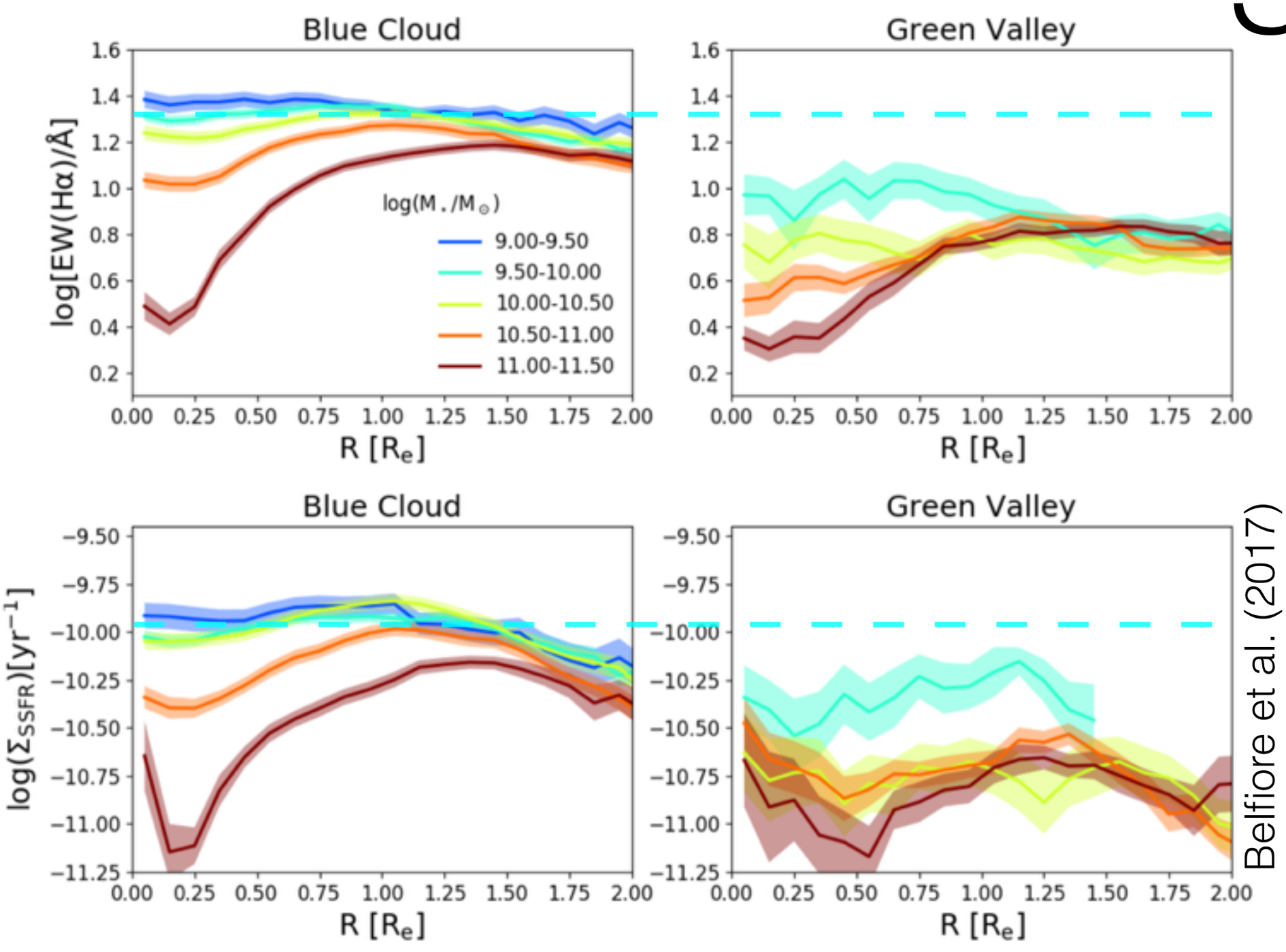
MaNGA Science

Red Geysers: Maintenance-mode AGN feedback in red galaxies

MaNGA Science

Star formation is suppressed:

- in the **centers** of massive blue-cloud galaxies
- **globally** in green-valley galaxies, relative to their blue-cloud counterparts

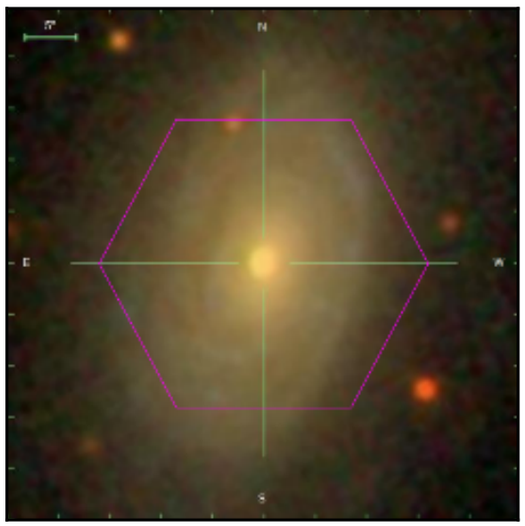


MaNGA Science

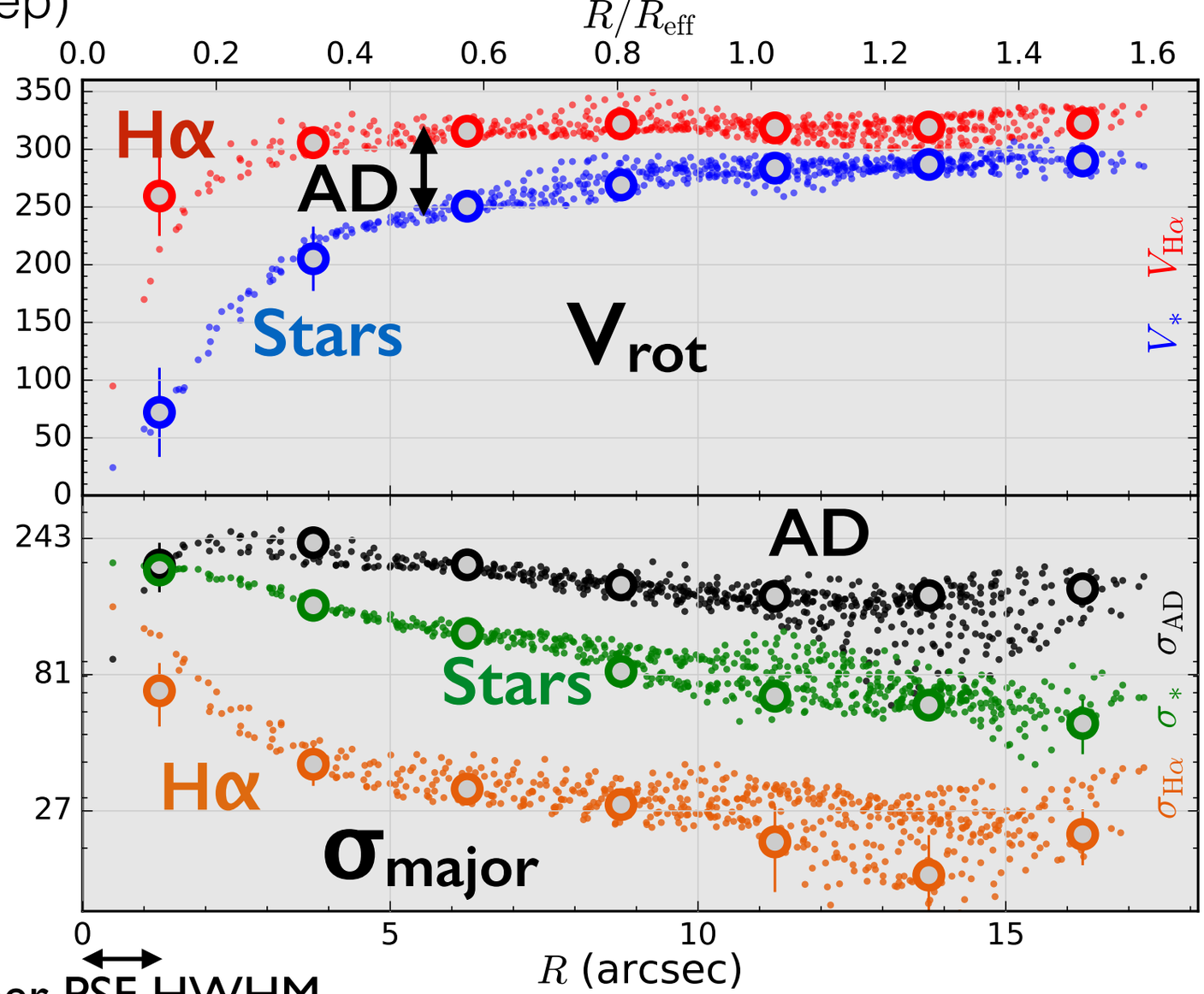
- Beyond global kinematic classification:
  - Resolved rotation curves for Tully-Fisher & mass decomposition
  - Velocity dispersion profiles for advanced dynamical modeling
  - Precise stellar and gas kinematics valuable for more subtle dynamical effects, like **Asymmetric Drift**

Westfall et al. (in prep)

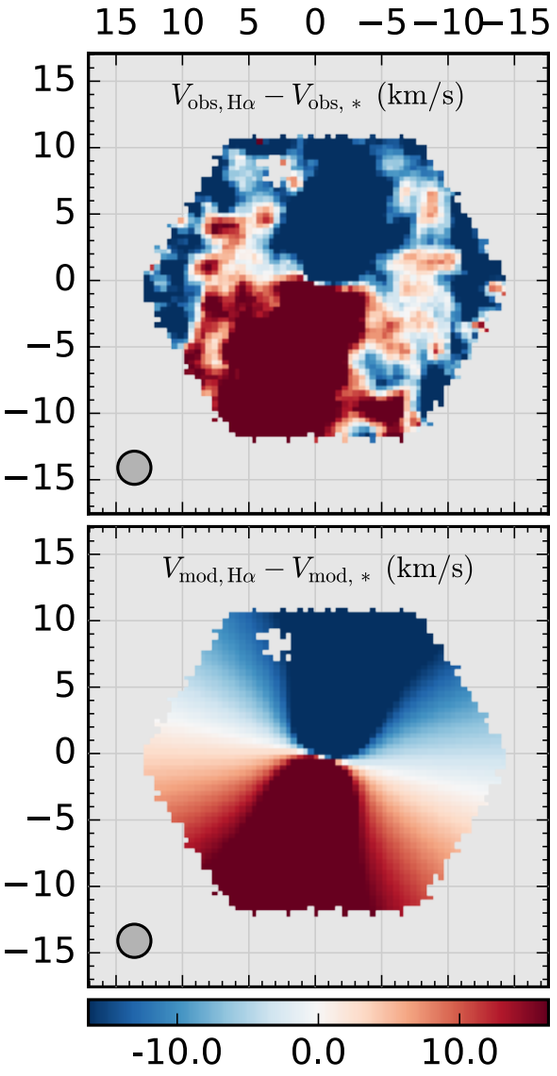
SDSS gri Composite



MaNGA ID: 1-339041
Observation: 8138-12704
Sample: Primary+
Kin Inc (deg): 53.4+/-0.1
Phot Inc (deg): 46.8
Inc (deg): 50.1
Reff (arcsec): 10.9



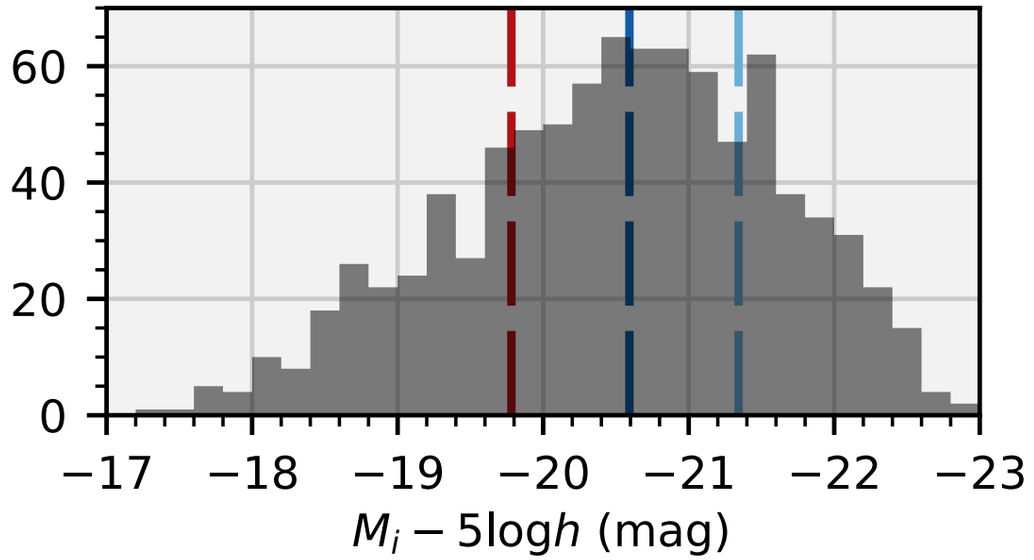
Hα - Stars

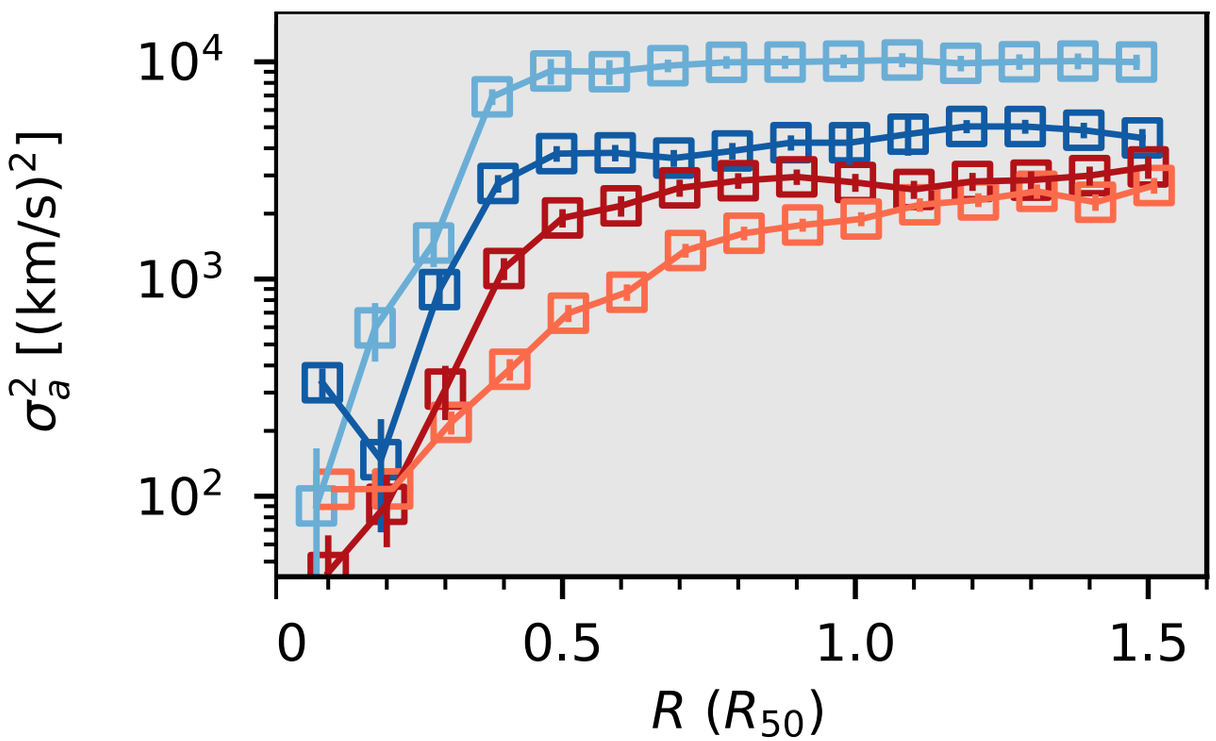


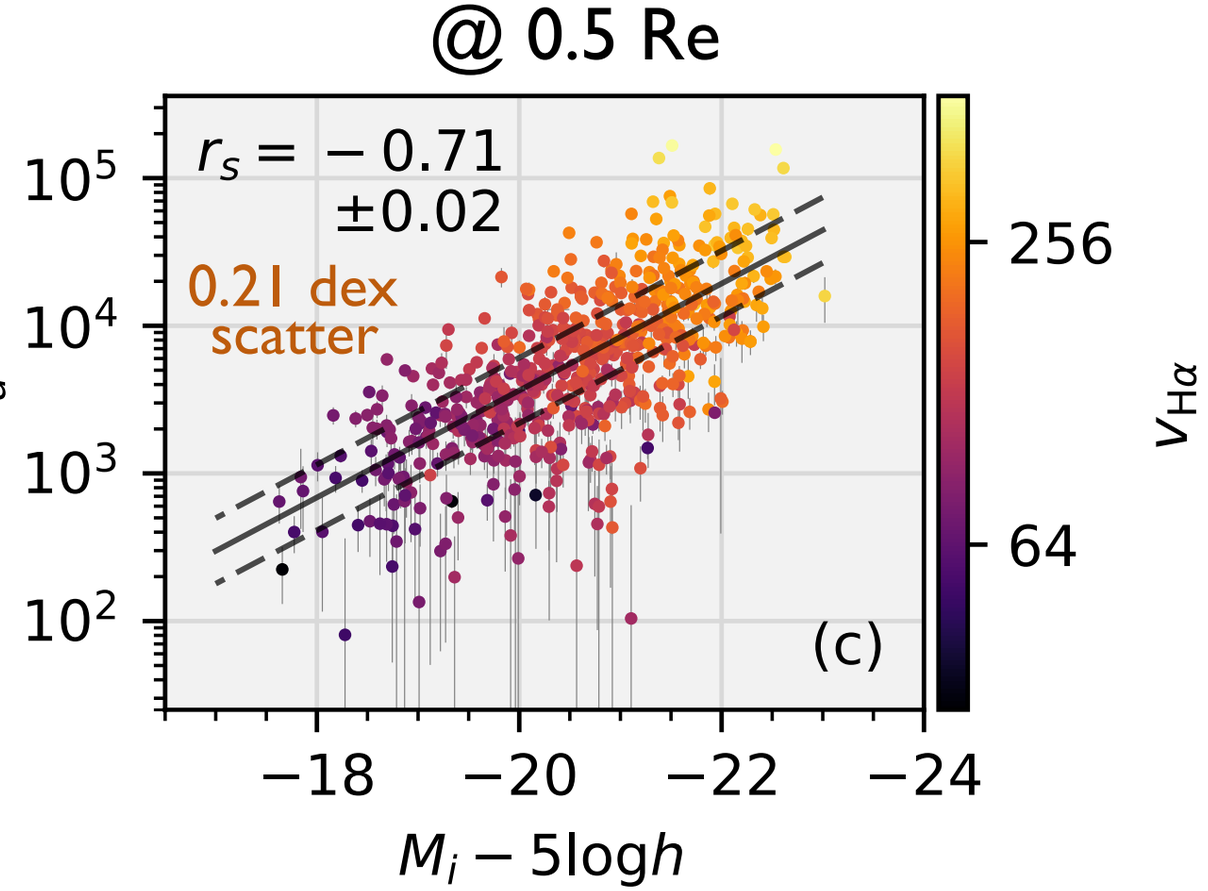
MaNGA Science

Define: $\sigma_a^2 = V_{H\alpha}^2 - V_\star^2$

There is clear trend of larger asymmetric drift for brighter galaxies.







Westfall et al. (in prep)

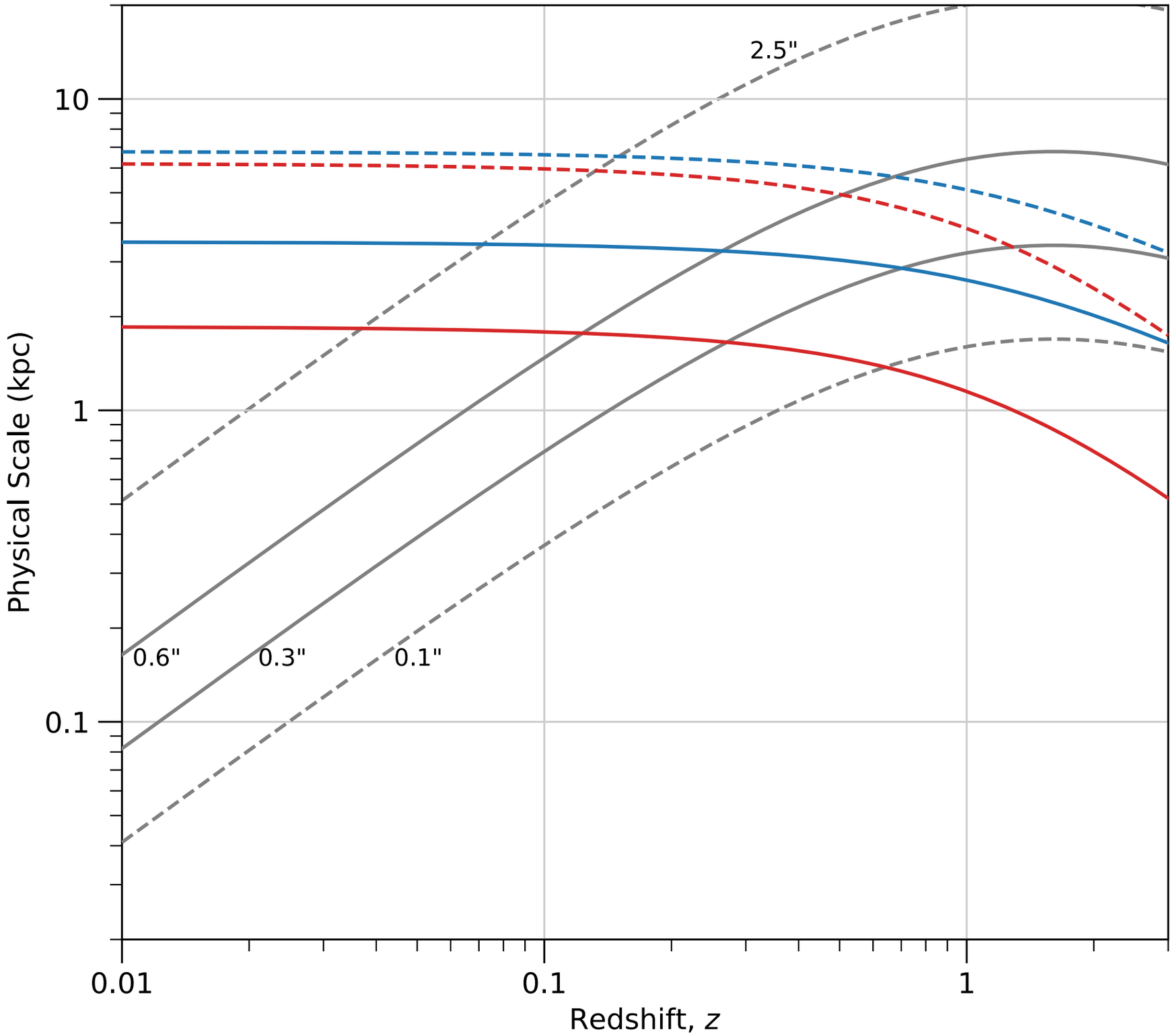
Bringing MaNGA-like Science to Keck/TMT *and intermediate z*

2D Integral Field

1-2 kpc spatial resolution

Large multiplex

Physical scales



$\log(M_\star/M_\odot) = 11.3$

Rodríguez-Puebla et al. (2017)

$\log(M_\star/M_\odot) = 10.3$

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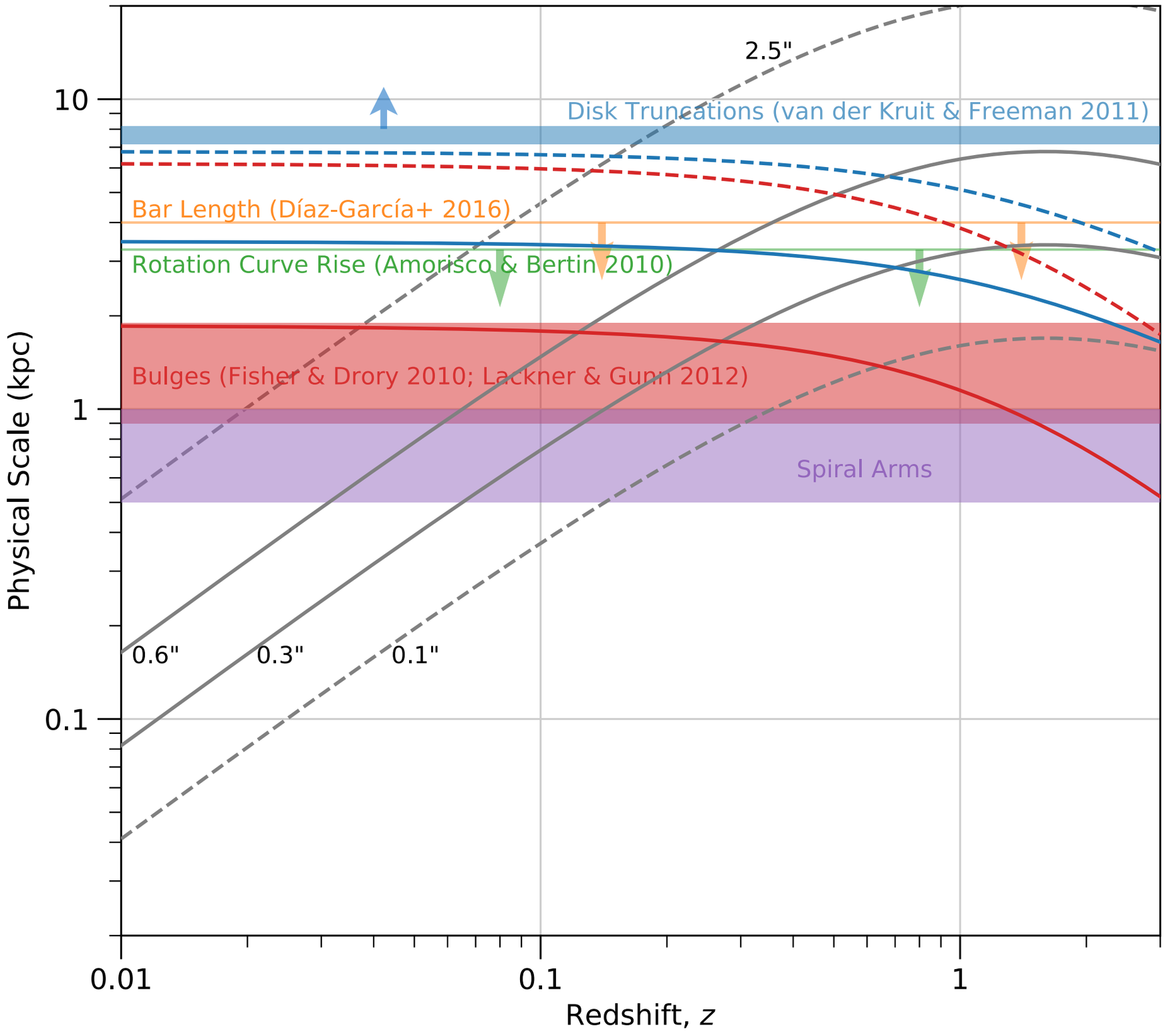
Physical scales



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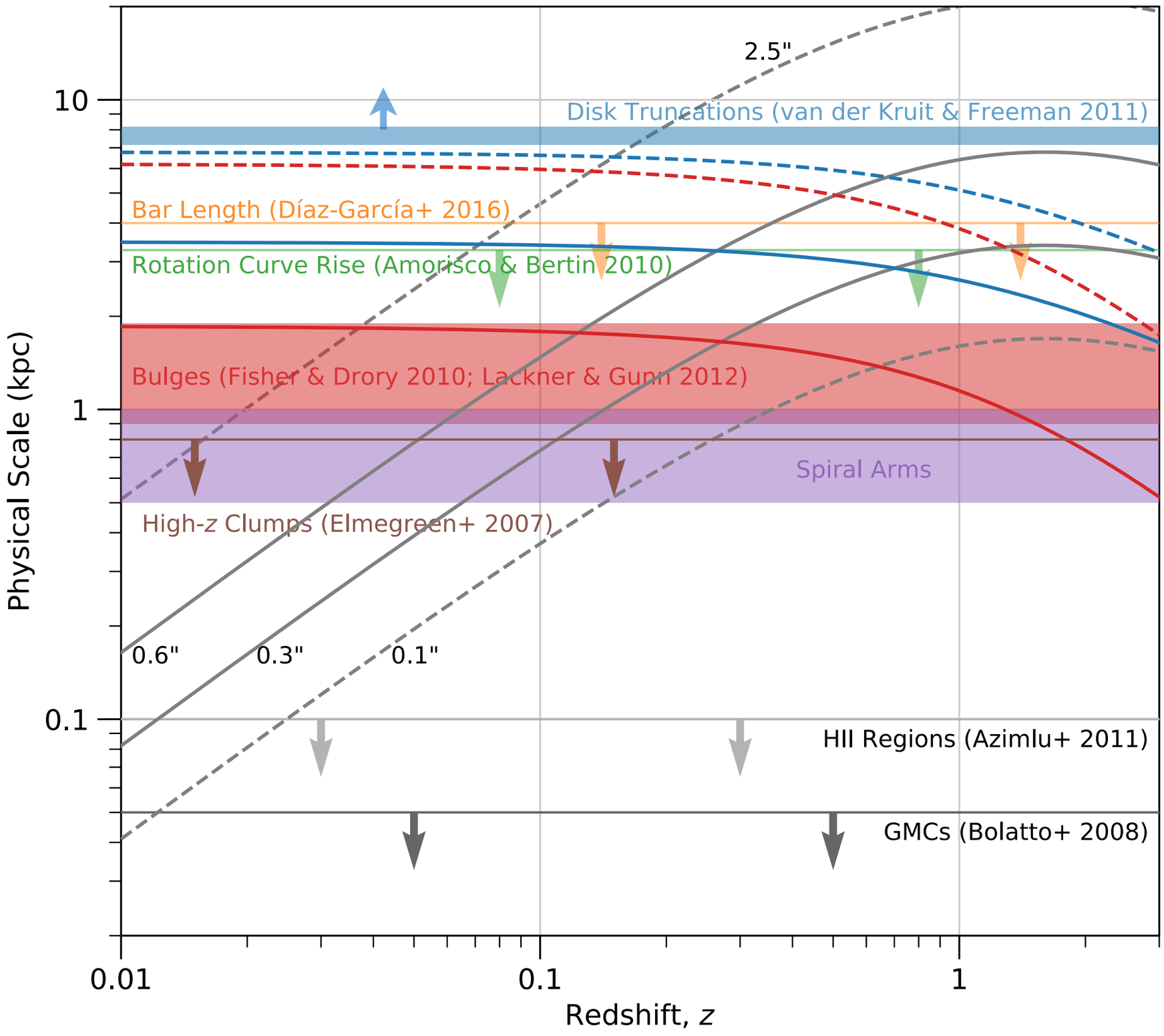

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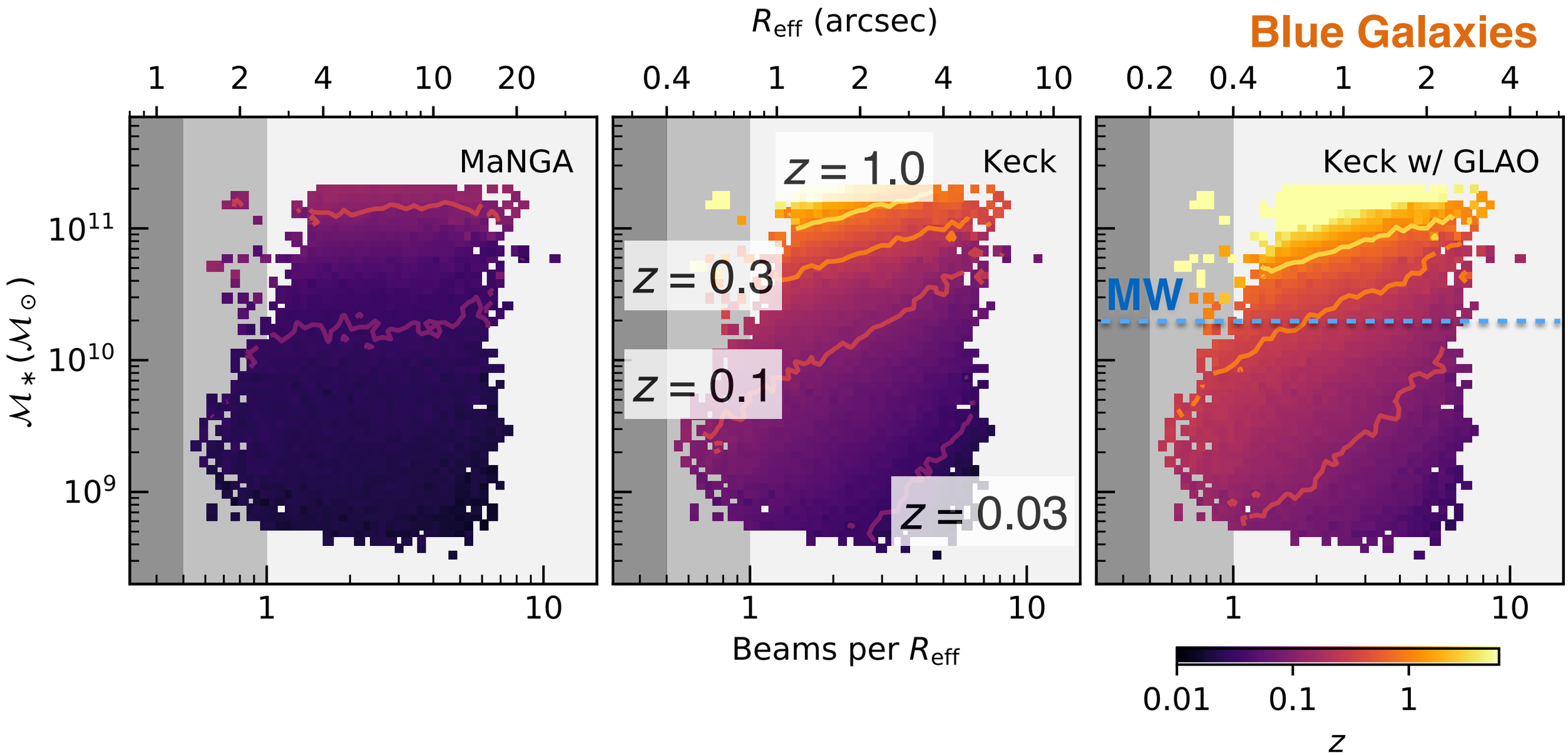
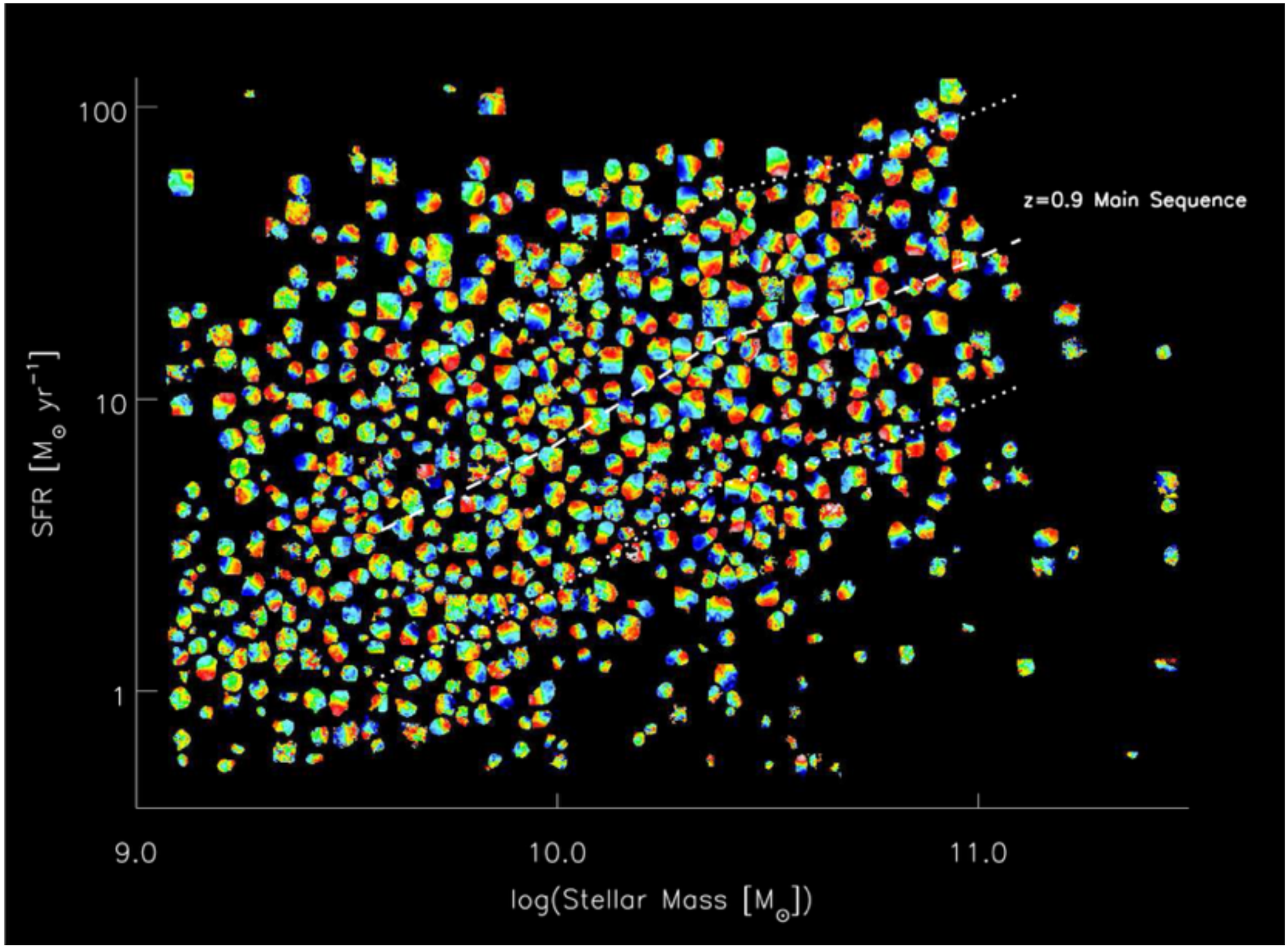
MaNGA-like Science at higher z



A point of reference

KMOS Redshift-One Spectroscopic Survey (KROSS)



Stott et al. (2016)

A point of reference

KMOS Redshift-One Spectroscopic Survey (KROSS):

- 24 IFUs each 2.8x2.8 arcsec FOV
- 0.2" sampling, median seeing of ~0.7"
- 7.2 arcmin diameter patrol field
- YJ grating: 1.03 - 1.34 micron @ R~3k-4k
- up to 20 objects per pointing

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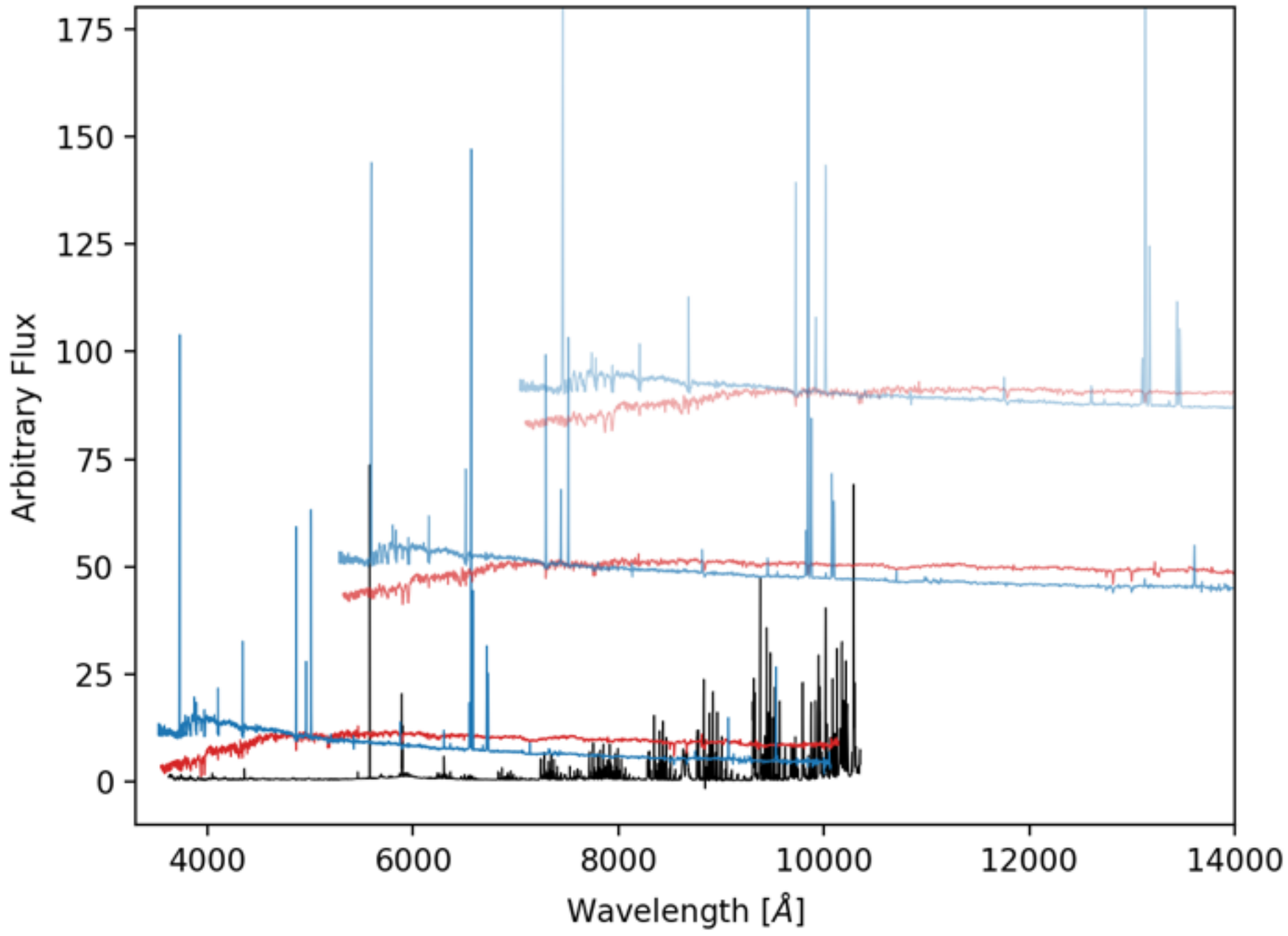
With a red limit at ~ 1 micron:

Restwave Red limit	Redshift	Restwave blue limit
730 nm (MILES)	0.37	256 nm
675 nm ([SII])	0.48	237 nm
525 nm (MgIb)	0.9	185 nm
501 nm ([OIII])	1.0	175 nm

A point of reference

With a red limit at ~ 1 micron:



Summary

- Spatially-resolved studies of large, statistically complete samples of galaxies, like **MaNGA**, are leading to a revolution in our understanding of galaxy evolution.

- MaNGA-like science up to z ~ 1, or further with GLAO, can be a design-driving science case for instrumentation at Keck/TMT; **however**, we need to work out the details.

- What are the trades between science and technical limitations due to:
  - spatial resolution (w/ and w/o GLAO)
  - sensitivity (w/ and w/o GLAO)
  - ***rest wavelength* spectral range**