The GTO Kmos Cluster Survey

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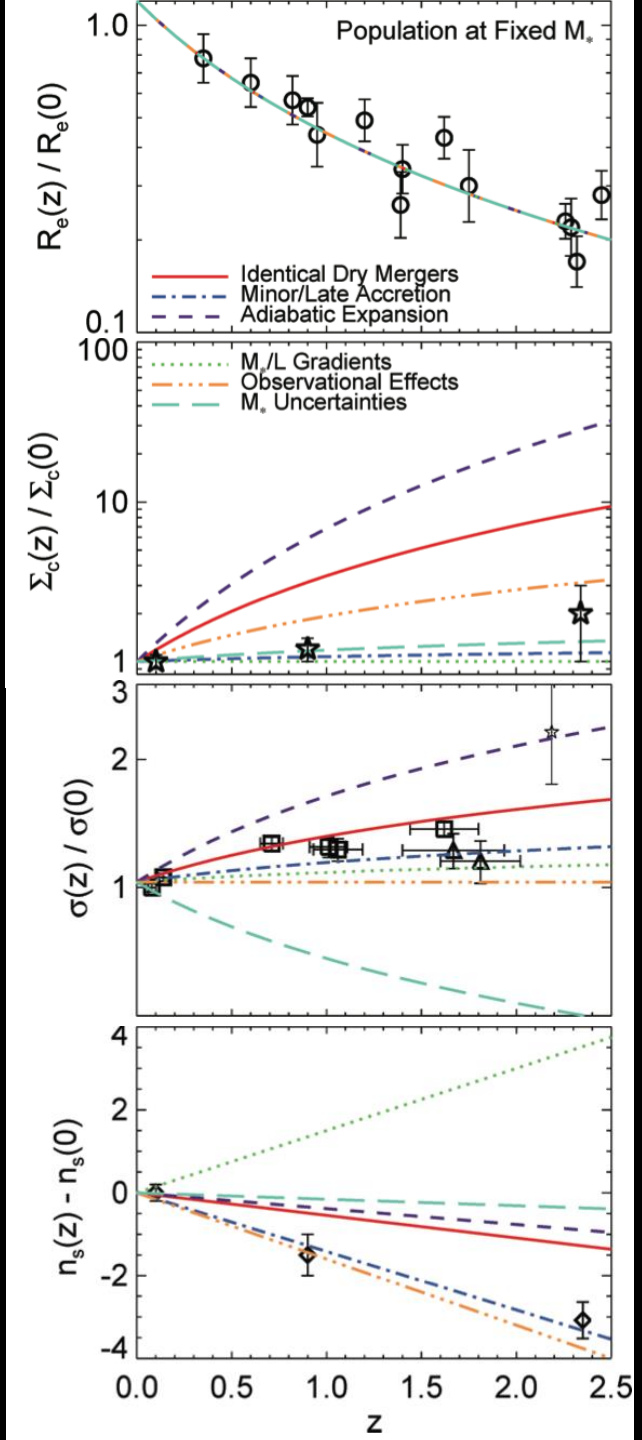
Outline

- Early-type galaxies: Big Questions
- KMOS: key advances
- KMOS Cluster Survey
  - Goals
  - Selection
  - Early results
- Summary

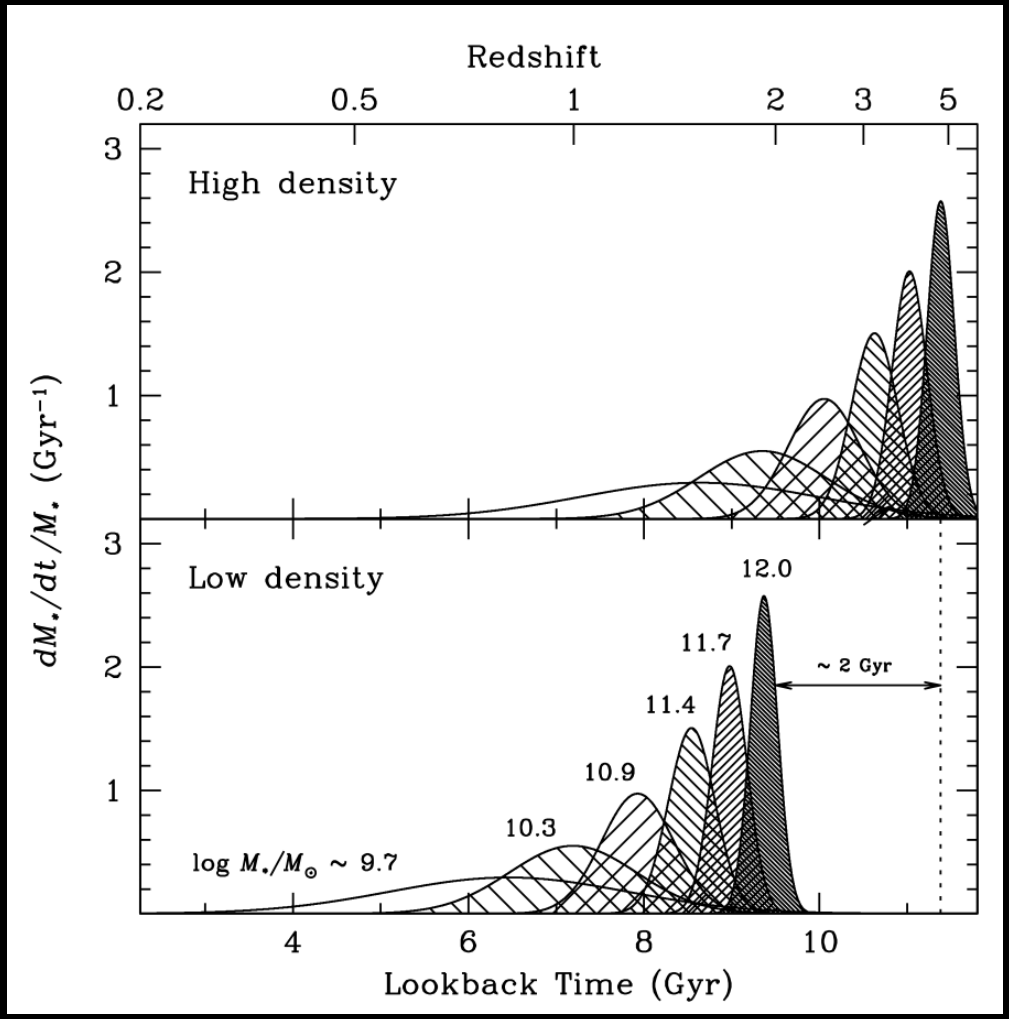
Early-type galaxies: Big Qs

- Size evolution (Trujillo+2007, van der Wel+2014)
- High-z ETGs have smaller R_e
- Identifying cause relies on high-z structure and σ measurements (Hopkins+2010, right)
- Current σ samples biased to massive ETGs and disagree



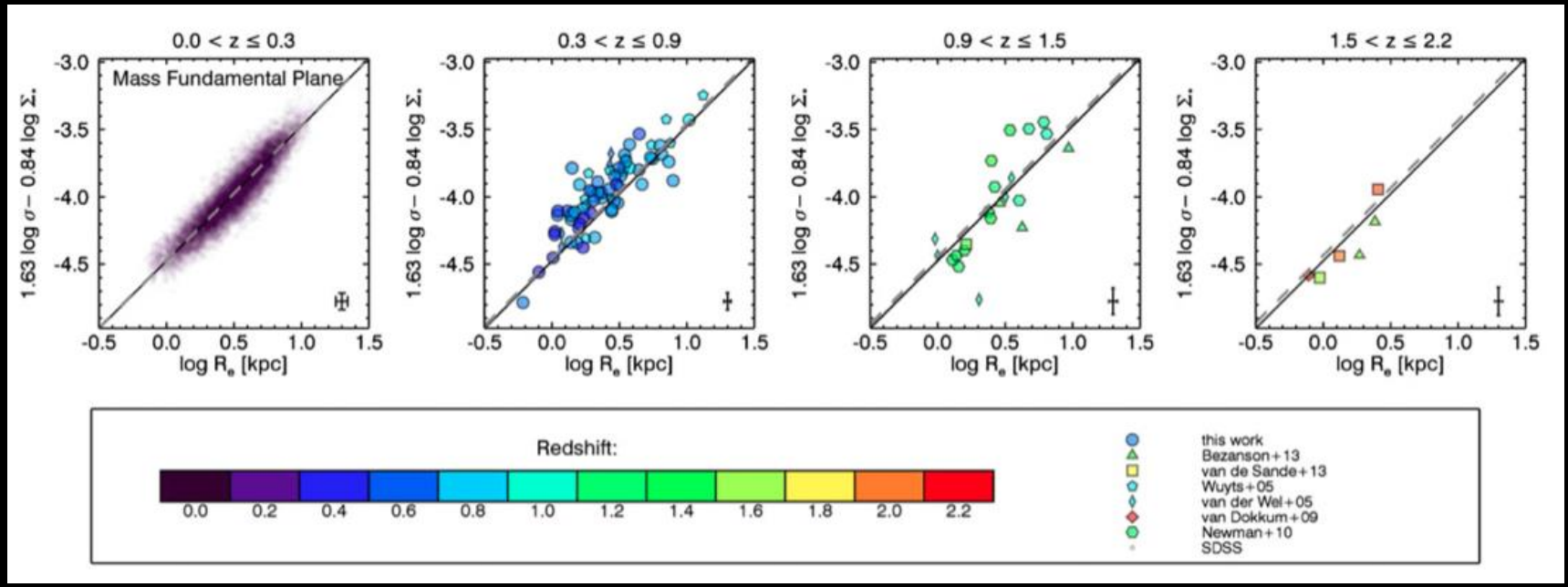
Early-type galaxies: Big Questions

- Downsizing (Cowie+1998, Thomas+2005)
- Most massive galaxies formed stars earlier and over shorter time periods from high-Z gas
- The same stellar ages/abundances at high-z need rest-frame V-band absorption line spectra



Early-type galaxies: Big Questions

- The Fundamental Plane (Djorgovski & Davis 1987, Dressler+1987)
  - High-z Evolution (Fritz+2009 Vs Holden+2010)
  - Stellar population correlations (Graves+2010, Springob+2012)
  - Universality and the mass-plane (Bezanson+13,14)



KMOS on ESO/VLT
PI: Ray Sharples (Durham)

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Durham UK ATC Oxford MPE USM ESO

KMOS on the ESO/VLT

Requirement	Value
Instrument Throughput	YJ>20%, H>30%, K>30%
Wavelength coverage	0.85 to 2.5 μm
Spectral Resolution	R>3300,3400,3800,3800 (IZ,YJ,H,K)
Number of IFUs	24
Extent of each IFU	2.8 x 2.8 sq. arc seconds
Spatial Sampling	0.2 arc seconds
Patrol field	7.2’ diameter field
Close packing of IFUs	≥3 within 1 sq arcmin
Closest approach of IFUs	≥2 pairs separated by 6 arcsec

KMOS: key advances

K-band Multi-Object (integral field) Spectrograph

- 24 arms → 24x longer exposure times, large samples
- Latest NIR detectors → as efficient as CCDs, low RON
- NIR bands: iz, YJ, H, K → rest-frame visible at high-z
- 8m M1 → S/N ~ 5-10 for $\log M_{\star}=10.7$ @ z=1.5 in 20hrs

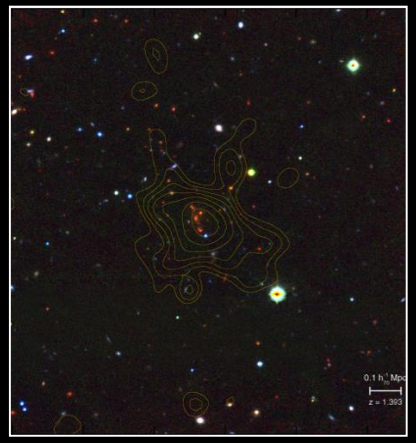
Plus:

- IFU → No slit losses
- R = 3000 – 4000 → work between the sky lines
- Seeing limited → integrated/unresolved properties

(GTO) KMOS Cluster Survey (KCS)

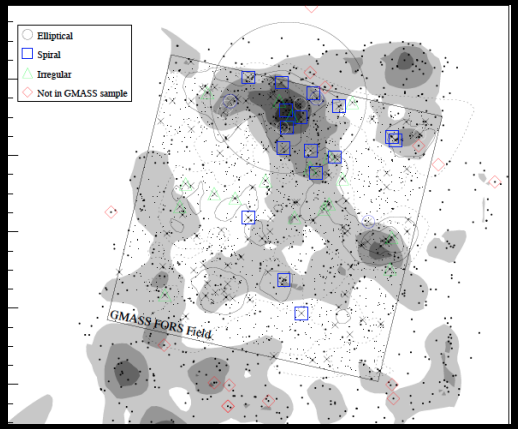
- PIs: Roger Davies (Oxford), Ralf Bender (USM/LMU/MPE)

XMMU J2235-2557
z-=1.39
(Mullis et al 2005)

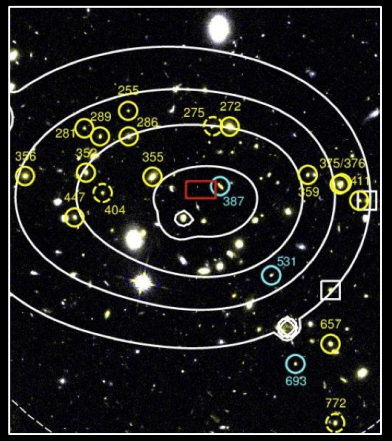


XMMXCSJ2215.9-1738
z-=1.46
(Jee et al 2011)

Cl0332-2742
z=1.61
(Kurk et al 2009)



JKCS 041
z=1.83
(Newman+2014)

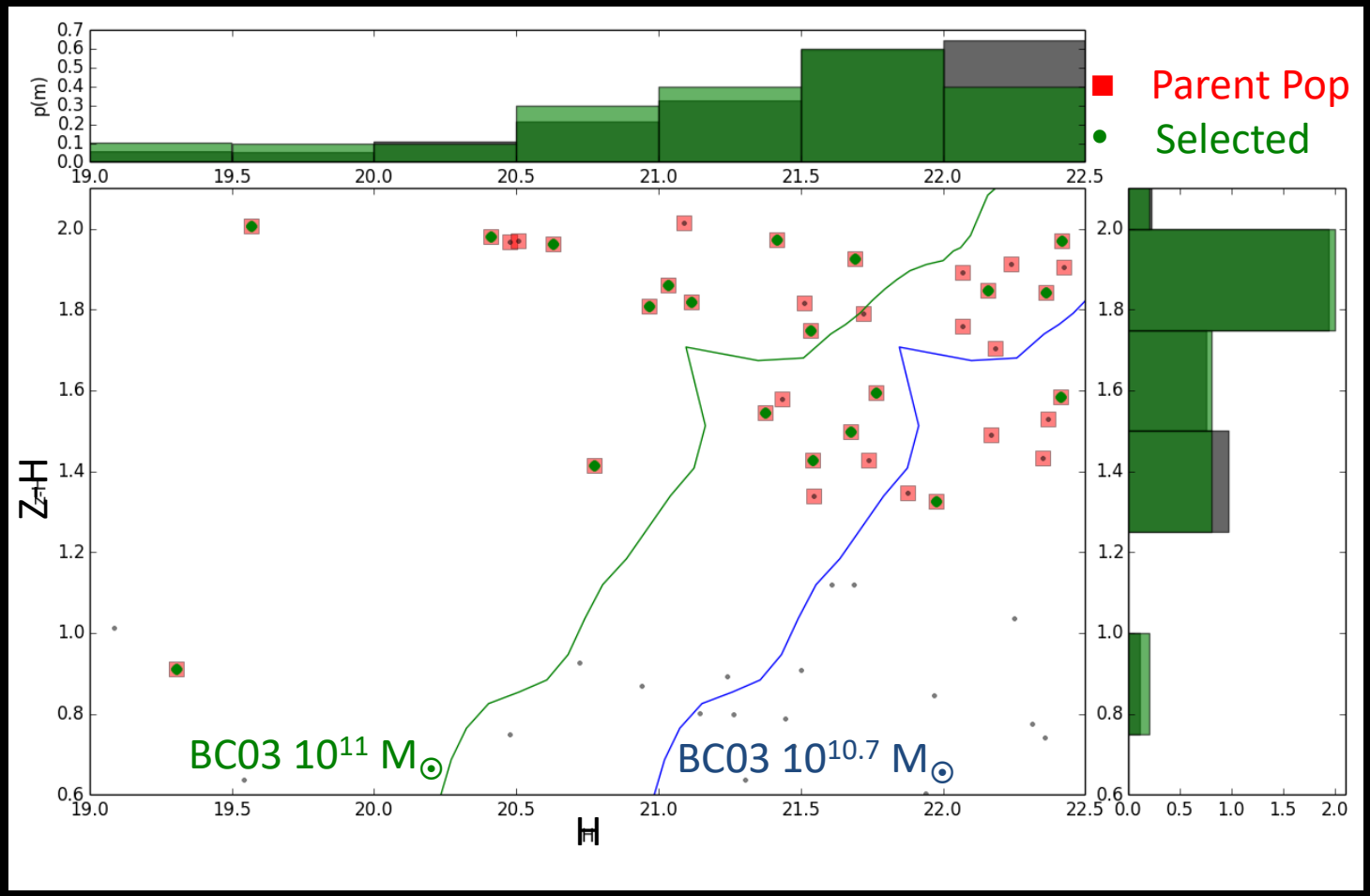


- Select 4 clusters 1.3<z<2.0 based on:
  - HST imaging (to measure structural parameters, e.g. R_e)
  - Key V-band absorption features free from sky/telluric lines
- 20 galaxies per cluster: >80 galaxies in total

CMDs/Selection

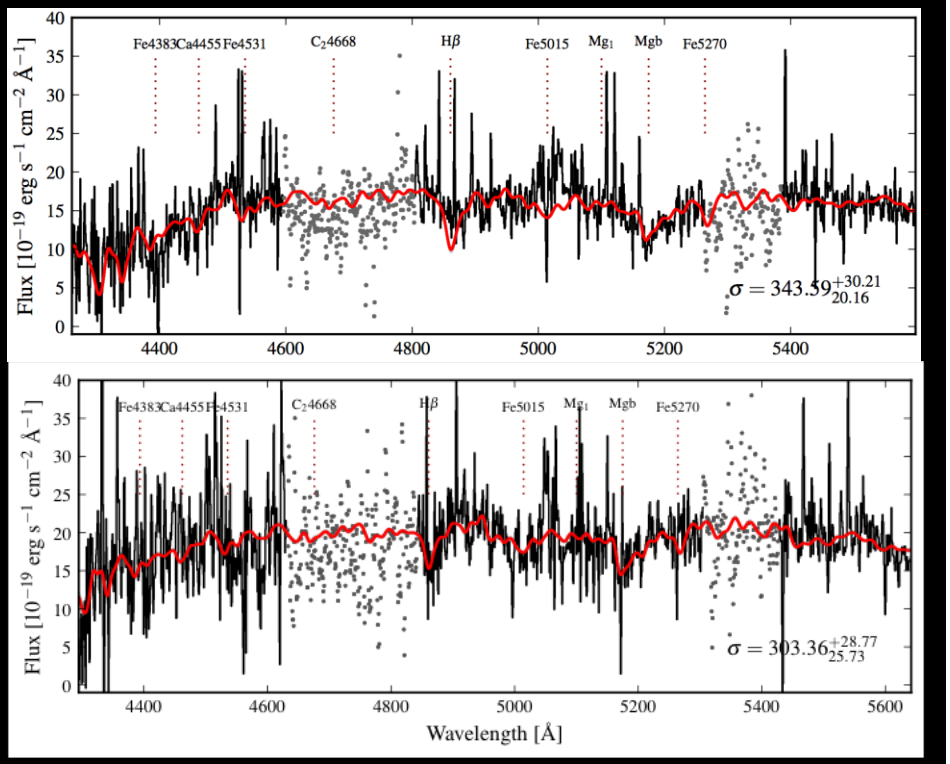
- Primarily select red sequence galaxies $\log M_\star = 10.7$
- Fill with confirmed cluster blue galaxies

e.g. XMMUJ2235 @ z=1.39

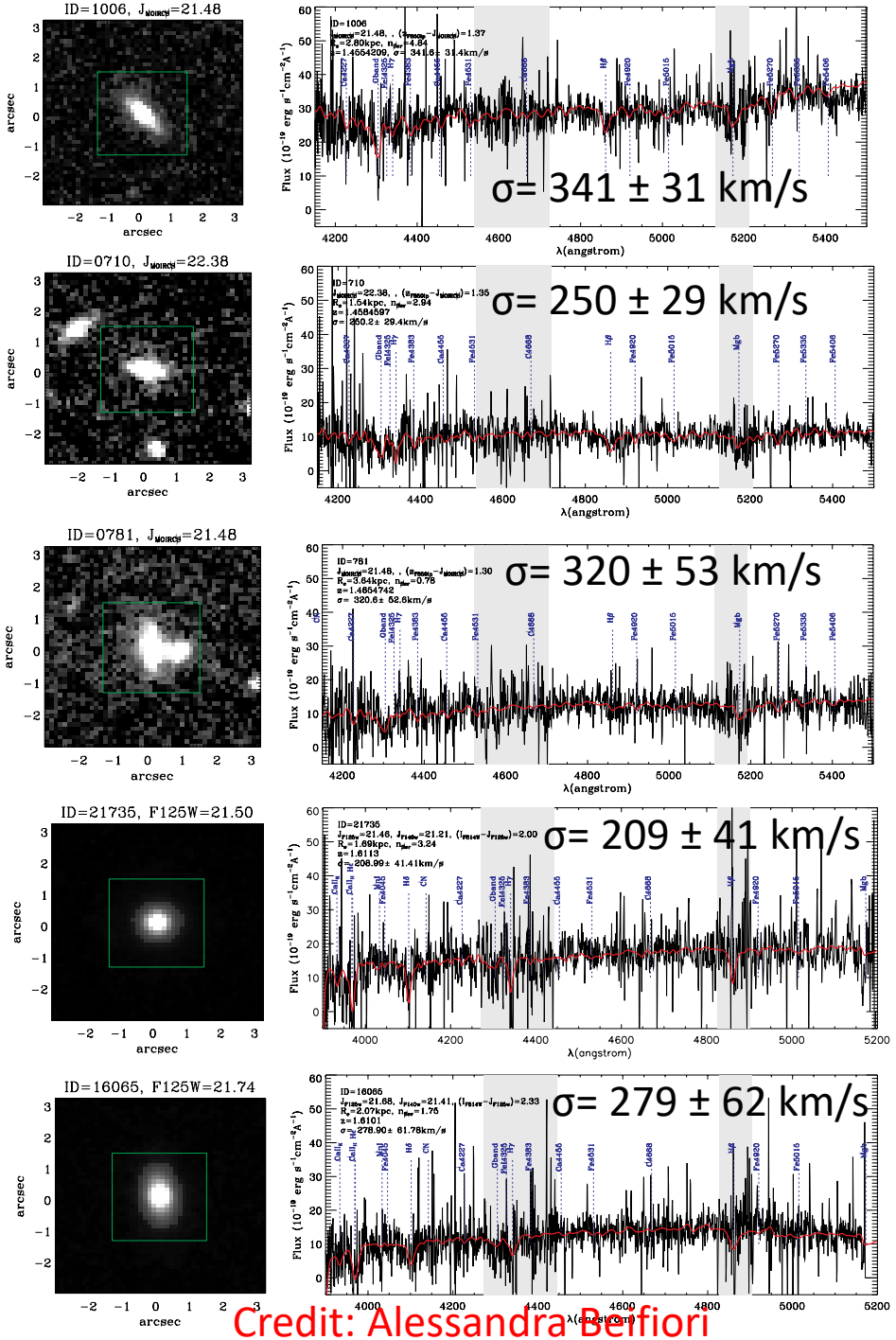


Early results: kinematic fits

- XMMU2215 z=1.45 (right)
- XMMUJ2235 z=1.39 (bottom)



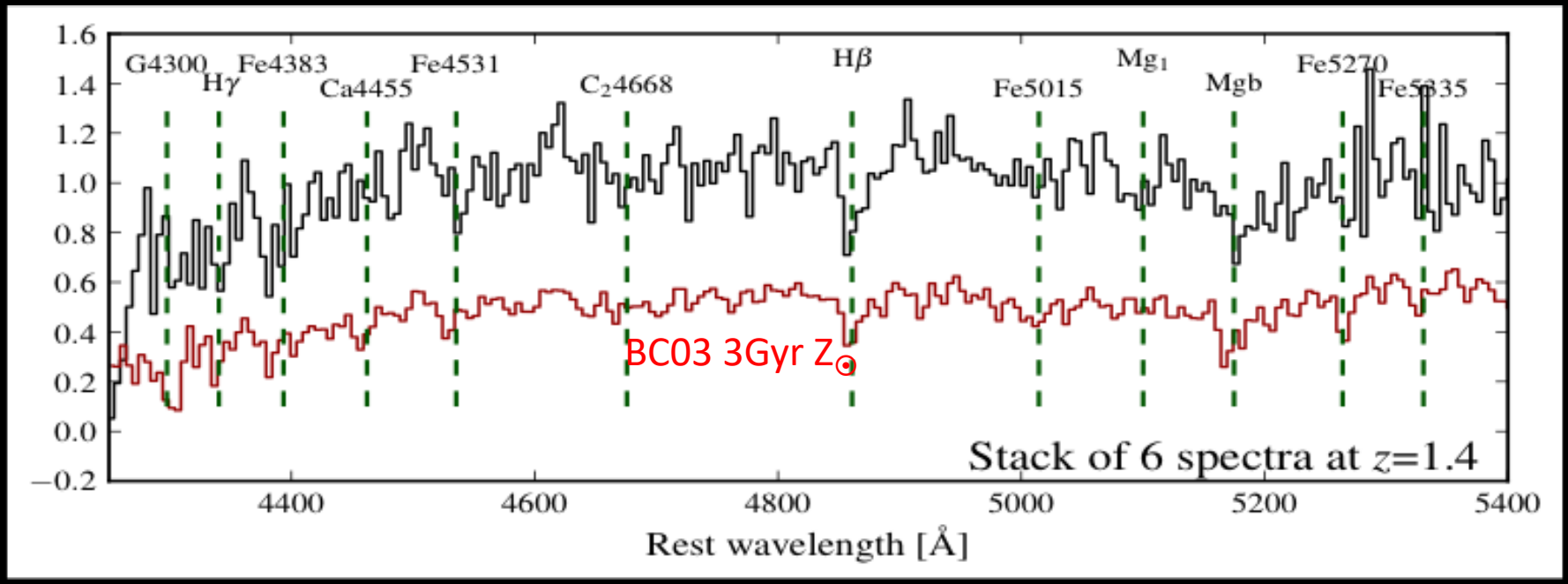
Credit: Trevor Mendel



Credit: Alessandra Beifiori

Early results: stellar populations

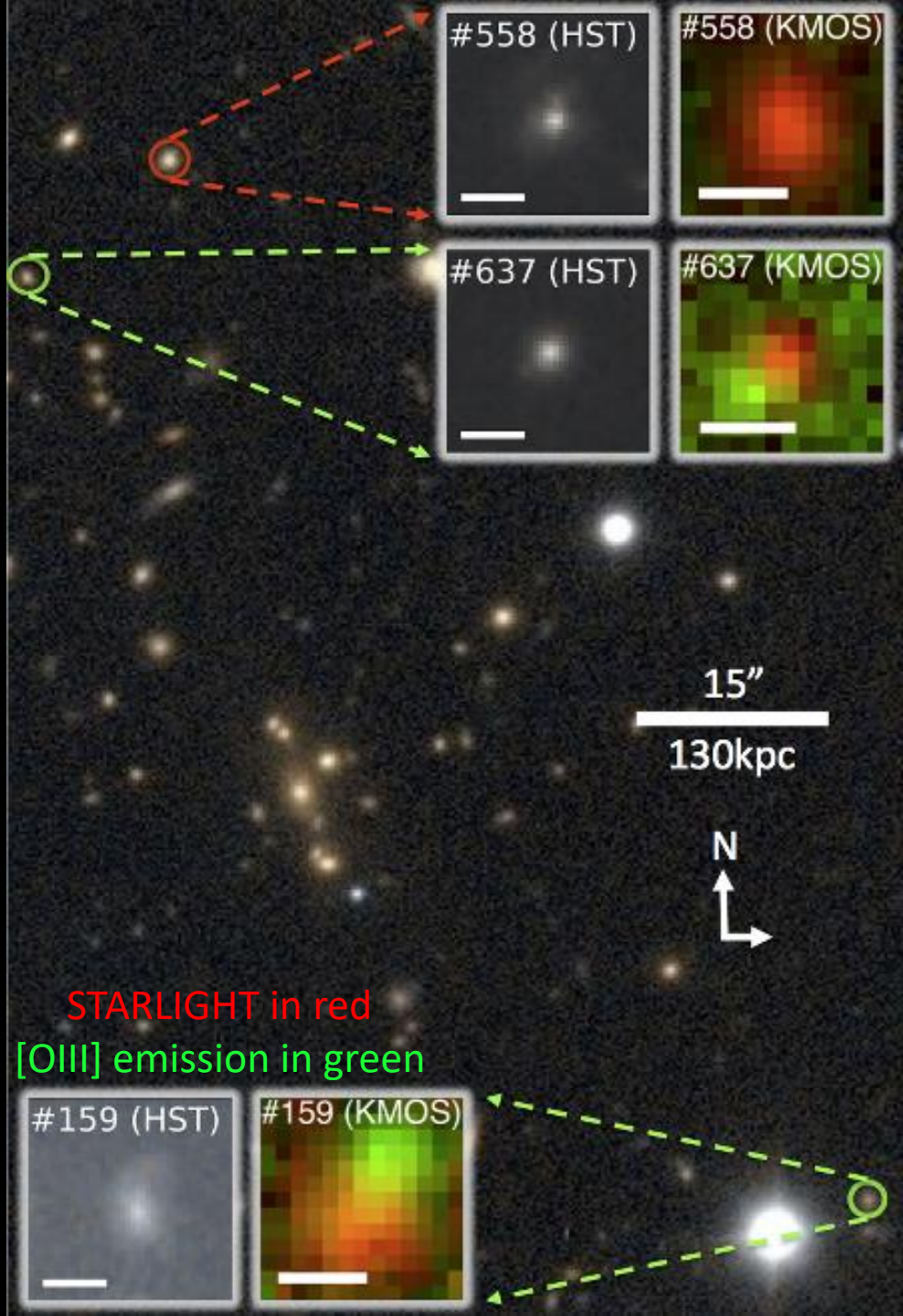
- Investigating stacked spectra



Credit: Trevor Mendel, Russell Smith

Quenching?

- XMMUJ2235 z=1.39
- [OIII] emission present in outer galaxies (outside X-ray emission)
- Position misaligned with starlight
- High velocity offset
- Investigating outflow/stripping options with X-ray and FIR data
- Comparison to sims



Summary

- KMOS Cluster survey on going (2/5 complete)
- V-band absorption line spectra providing:
  - Stellar kinematics
  - Stellar populations
  - Ionized gas emission
- Key advances that allowed this:
  - Multiplexed IFUs
  - Efficient NIR detectors