CLUSTER GALAXIES AT REDSHIFT 1 < z < 2:

Plans and preliminary results from the KMOS-clusters program

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& KMOS-clusters GTO team

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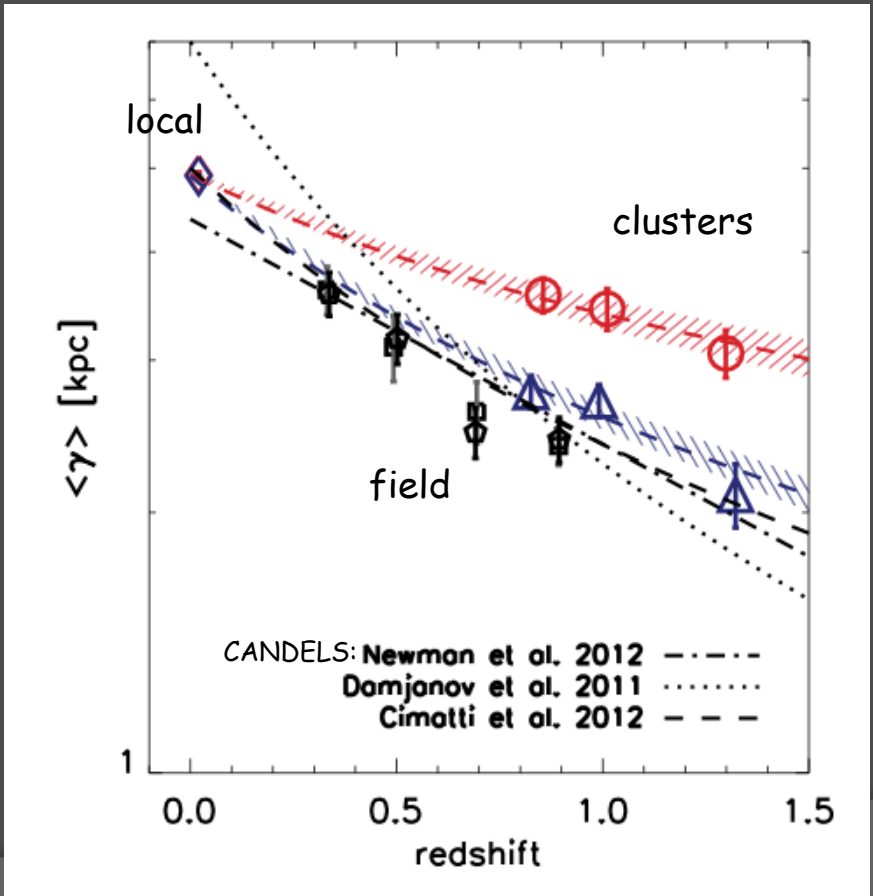
Early-type galaxies at z>1

- Early-type galaxies (ETGs) at z>1: smaller sizes, higher density and larger stellar velocity dispersion than local counterpart at similar mass (Fernando Buitrago's talk yesterday)

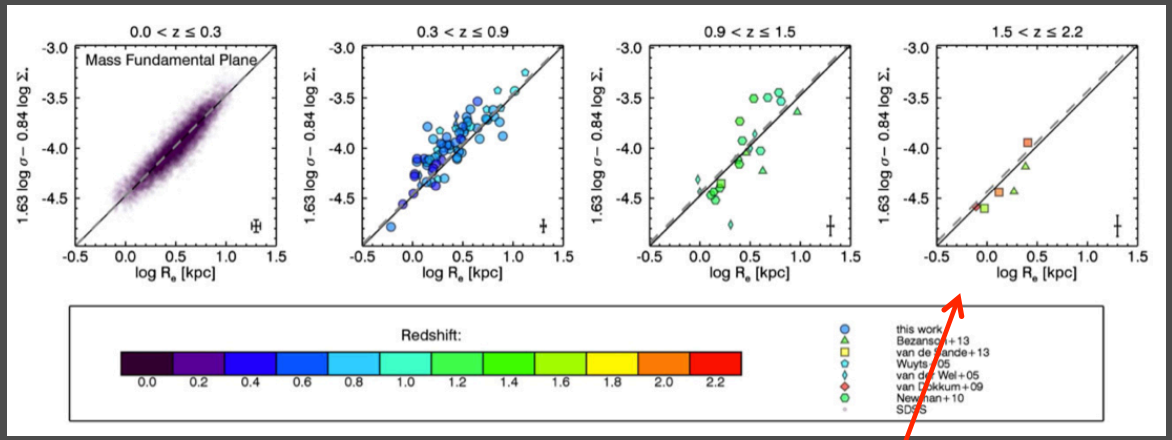
Delaye et al 2013



Accelerated structural evolution in high-z dense environments?
(e.g Delaye et al 2013, Strazzullo et al 2013, Lani et al 2013...but see Rettura et al 2011 & Saracco et al 2014 for different opinion)

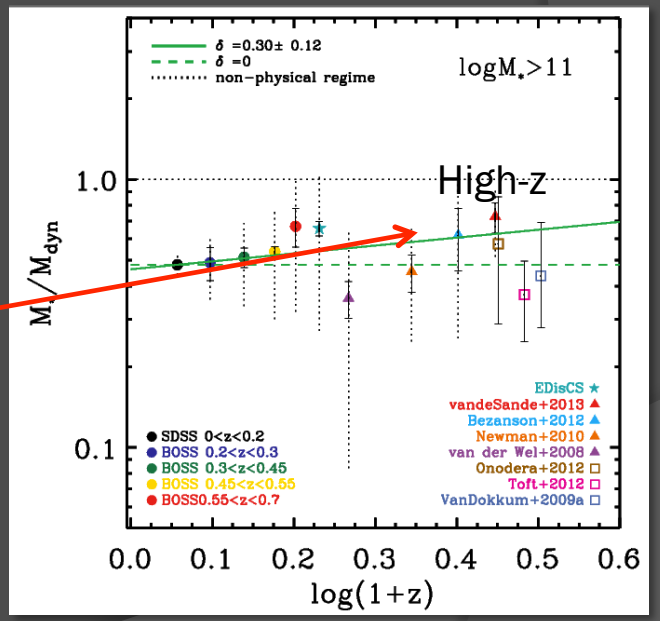
Early-type galaxies at z>1

Why do we want to study absorption line kinematics?



Mass fundamental plane from Bezanson et al 2013

Beifiori et al 2014, BOSS+high-z



Current samples small!

We are limited to massive galaxies!

Reason: extremely long integration times!

→ larger and more homogeneous selection is needed!

(see also Trevor Mendel's talk yesterday)

$M_\star/M_{dyn}$: potentially tracer of the mechanism by which galaxies grow (Hopkins et al 2009, Hilz et al 2013a,b)

KMOS-clusters program

PIs: R. Bender (USM/MPE) & R. Davies (Oxford)

- Goals: derive stellar velocity dispersions, sizes, resolved stellar masses, absorption line indices (Ryan Houghton's highlight talk given by Trevor Mendel yesterday!) to study scaling relations and fundamental plane evolution to constrain formation history of early-type galaxies in clusters!

  - comparison with deep field (i.e. VIRIAL, Trevor Mendel's talk): isolate role of environment!
  - strong effort in comparison with predictions from models!

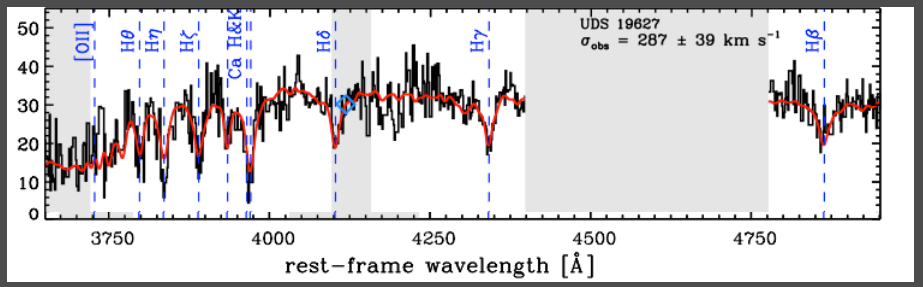
- Methods: deep spectroscopy in known X-ray selected clusters at $1<z<2$, for a sample of > 20 galaxies in each clusters with available spectroscopic redshifts and HST imaging.

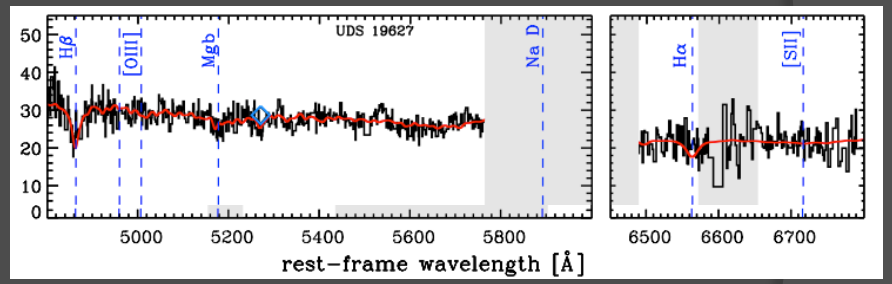
  - critical epoch: diversity of the Hubble sequence established at $1<z<2$
  - Total: sample of > 80 galaxies at $z>1$ (IZ, YJ bands)

Why absorption line kinematics with KMOS?

KMOS advantages:

- NIR spectroscopy at z > 1.3
  - ETG's strongest spectral features (Ca II H+K, g-band, MgI.....) → into NIR (KMOS iz, YJ bands)
  - BUT: ....ETGs at z~2 are faint!!! Long integrations times (>12 h) + very strong sky emission!





Van de Sande et al 2013, x-shooter spectrum

- Multi-object IFU allows to simultaneously observe several galaxies
- The KMOS patrol field ~ extent of the clusters on the sky
- IFUs match the sizes of the galaxies
- GTO resources needed for a comprehensive study!

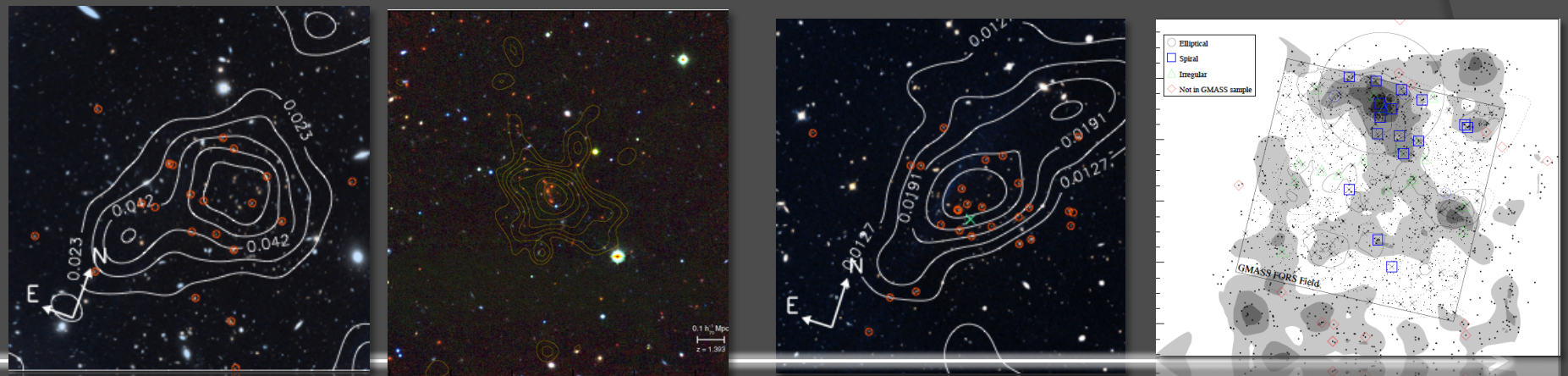
KMOS-clusters: cluster sample

RCS234526-3632.6
z=1.04
(Jee et al 2011)

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)



redshift

REQUIREMENTS:

- Multi-band HST photometry (for measuring sizes, and deriving morphologies)
- deep ground-based imaging (for red-sequence studies and SED fitting)
- large number of spectroscopically confirmed members, maximizing our selection efficiency
- redshifts such that → uncontaminated absorption lines (Balmer, Mg & Fe lines) from sky/telluric

KMOS-clusters: galaxy selection

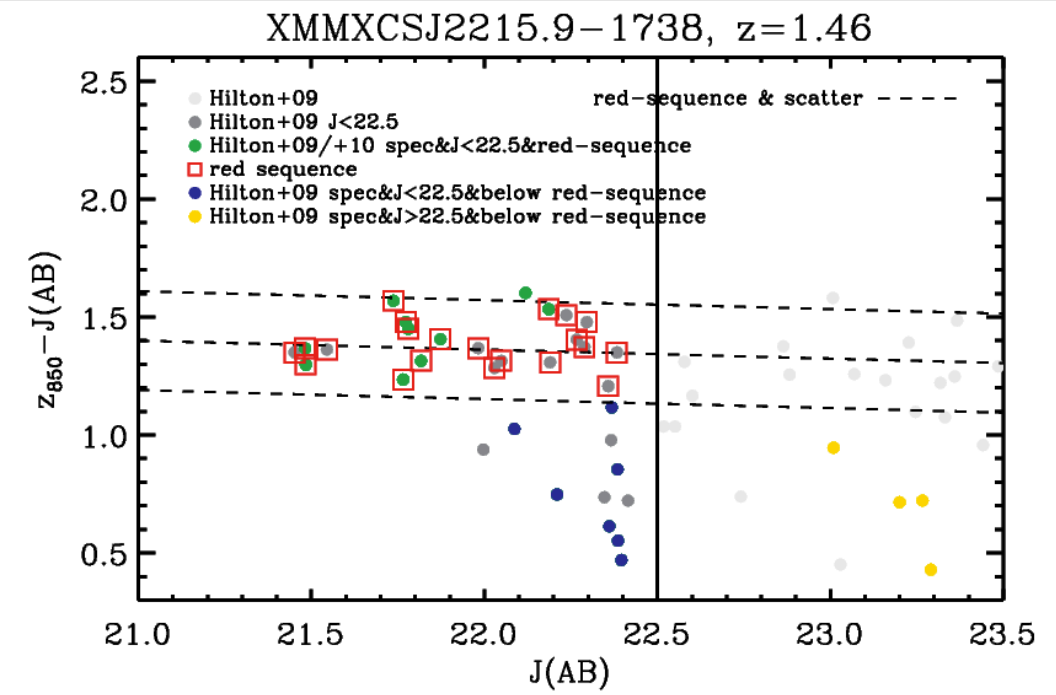
Selection based on priority:

1- pre-existing spectroscopic membership catalogs on red-sequence below J(AB)< 22.5 mag (or equivalently z(AB)<23.0mag, H(AB)< 22.0mag)

2- galaxies on the red-sequence

3- galaxies below the red-sequence and spectroscopically confirmed

(4- faint galaxies below the red-sequence with spec-z, needed to fill the setup→[OIII])

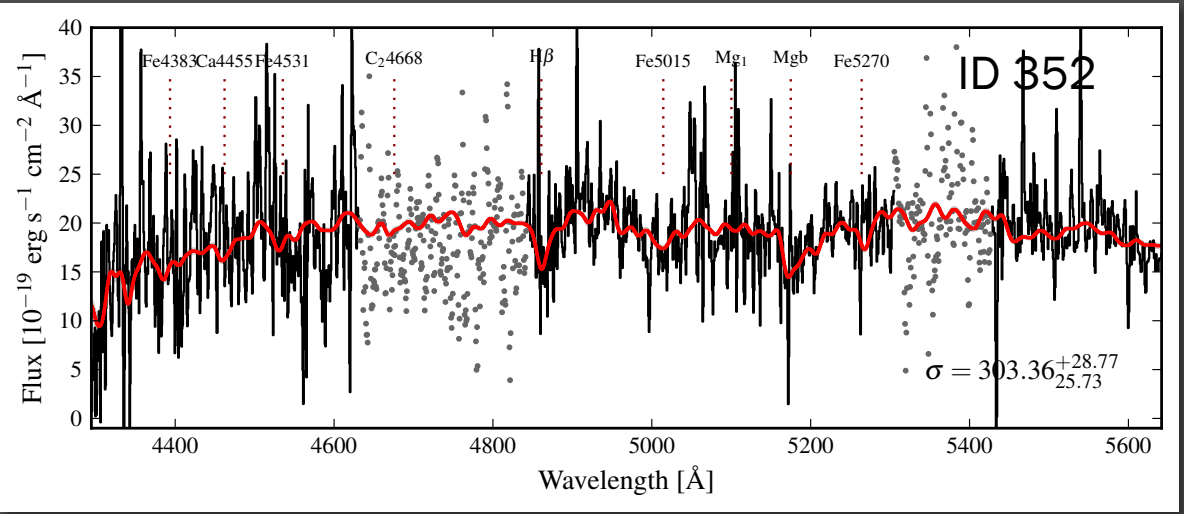


> 20 galaxies *in each cluster*! (i.e. 1 or 2 KMOS pointings)

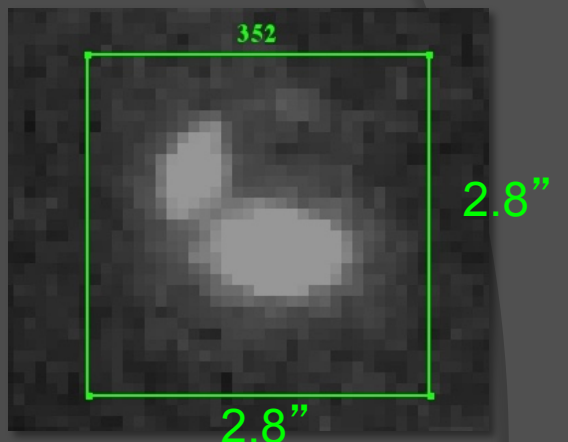
KMOS-clusters: preliminary spectra

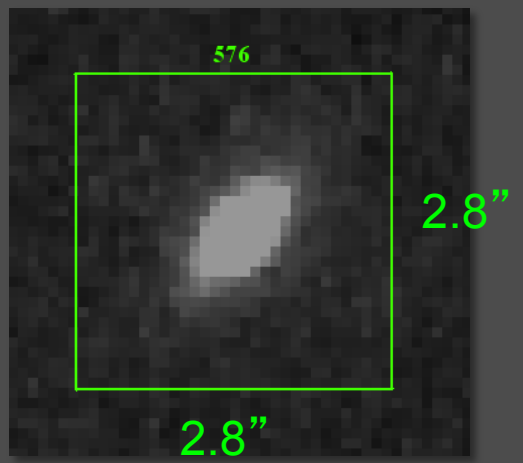
XMMU J2235-2557

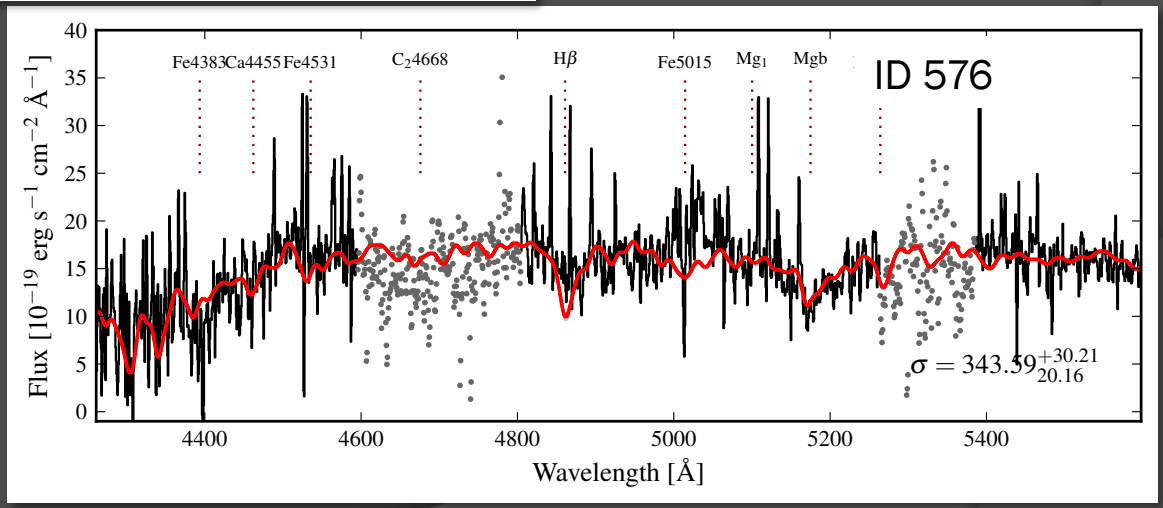
Exposure time=11.25 h



Priority 1 objects

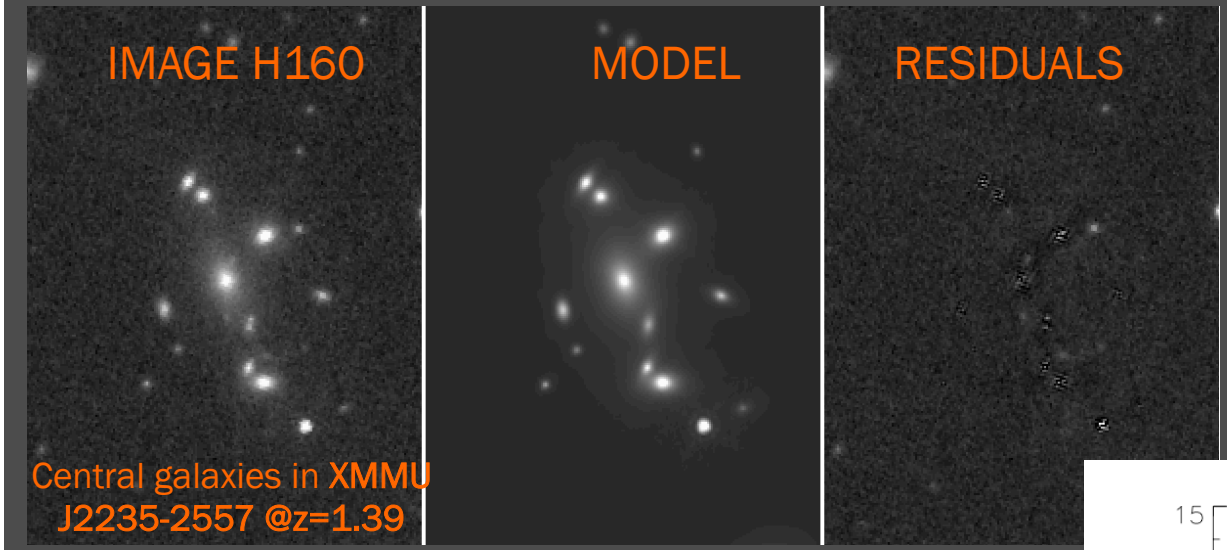




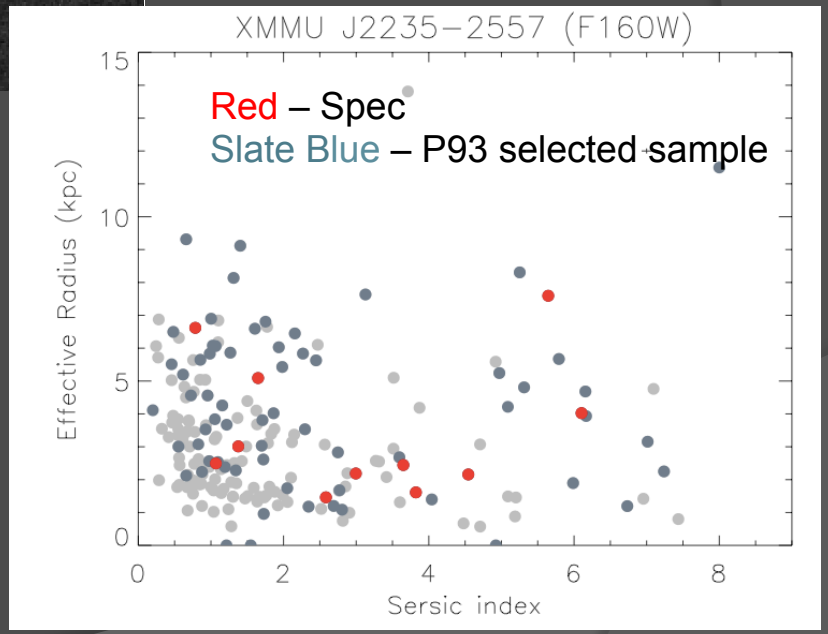


Very preliminary spectra & fits! - Credit Trevor Mendel-

KMOS-clusters: preliminary structural parameters



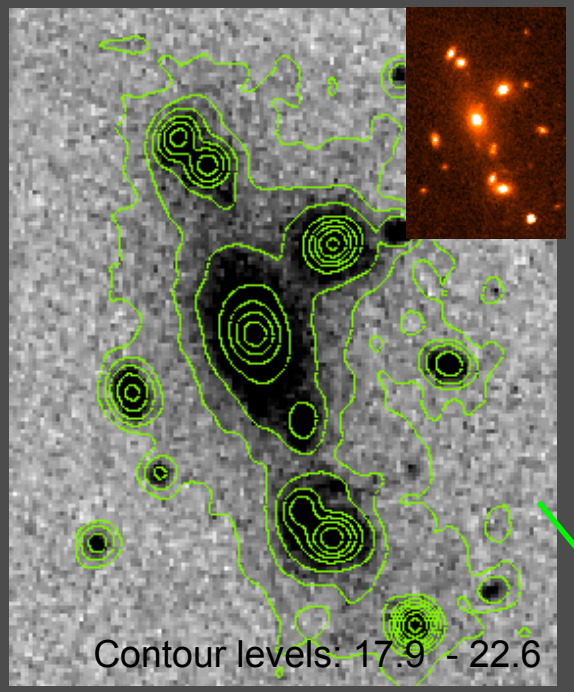
Sersic fit in multiple bands for each galaxy in each cluster using an improved version of Galapagos



Spectroscopic confirmed objects — large (n > 3 ~ early-types)....

- Credit: Jeffrey Chan-

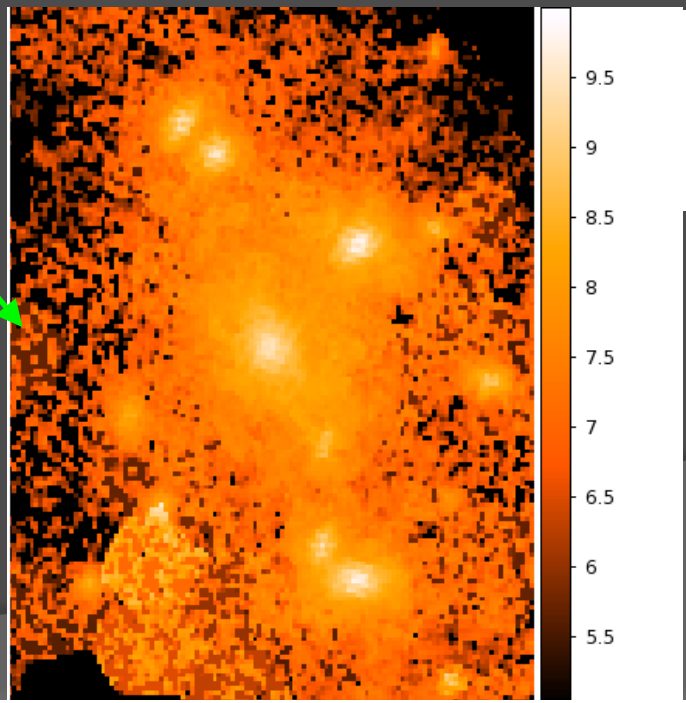
KMOS-clusters: preliminary resolved stellar mass maps from M_*/L -Color Relation



H160 Image

- Developed a method to derive stellar masses from colors-M/L relation using NMBS/COSMOS data. Integrated & resolved!
- From the resolved M/L-color relation, attempt to derive resolved stellar mass maps
- Mass-weighted structural parameters: Sersic fit on Voronoi binned mass bins → work in progress...

Stellar mass surface density map
Very preliminary!!



Stellar mass Surface density

Voronoi-binned Color (S/N~10 per bin)-> applied to image → stellar mass surface density!

- Credit: Jeffrey Chan -

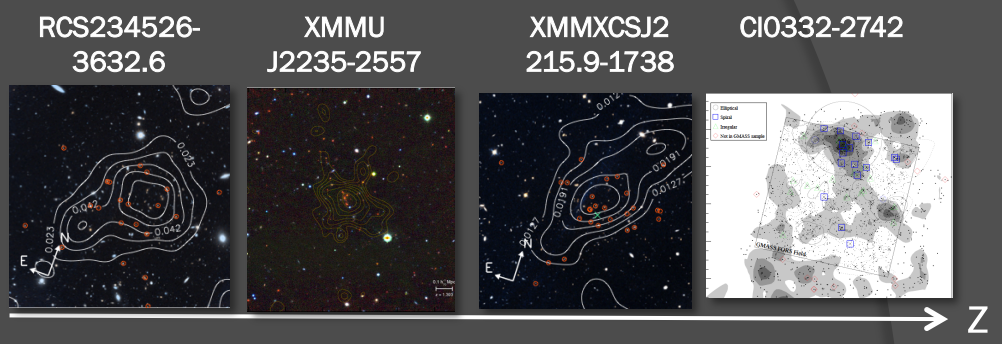
Summary

- KMOS-clusters:

GTO program for deep

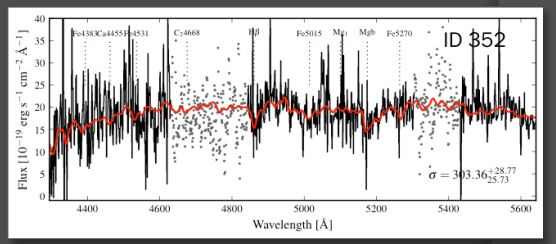
spectroscopy in ~ 20 galaxies

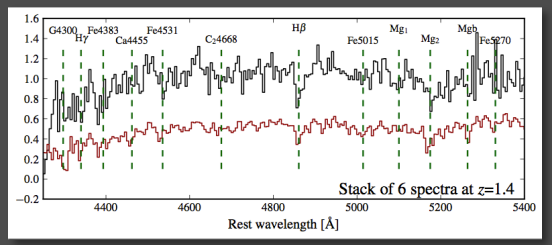
in each of the 4 cluster at 1<z<1.6

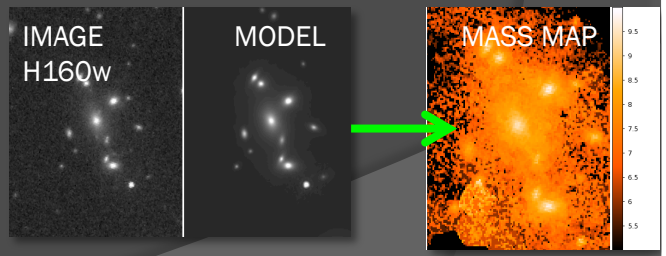


- Goals: constrain ETGs formation history!

- stellar velocity dispersions
- half-light and half-mass sizes
- absorption line indices
- scaling relations
- FP evolution....







- preliminary P92 data analysis & resolved stellar masses look promising!

... More will come...