An ESO/RadioNet Workshop
ESO Garching, 10–14 March 2014

3D2014

Gas and stars in galaxies: A multi-wavelength 3D perspective

Highlight talk session 7
Thursday 11:00

- **Rettura**
- **Mendel**
- **Houghton**
- **Richard**
- **Lee**
- **Troncoso**

The KMOS Spectroscopy of Galaxy Clusters at 0.8 < z <1.6

Alessandro Rettura
JPL - Caltech

Jet Propulsion Laboratory
California Institute of Technology

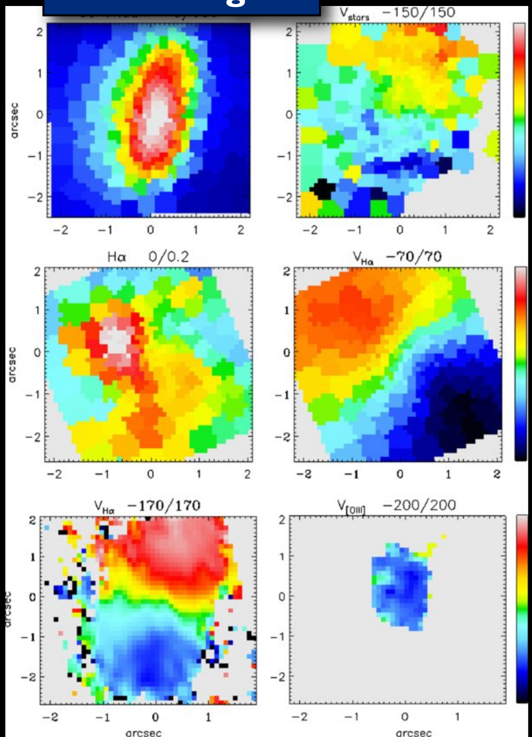
Cluster galaxies in 3D: main science drivers

To study in details the physical processes that shape the properties of **cluster galaxies at both intermediate redshift (0.8< z < 1.2), and at higher redshift (1.2 < z < 1.6).**

Catching galaxy transformations in the act in a cosmic epoch of active stellar mass build-up and when the Red Sequence in clusters becomes fully established.

To exploit the 3D capabilities provided by new instruments **(VLT, Gemini, Magellan**, **ALMA) to map out the kinematical structure, spatial distribution and overall properties of the ionized and molecular gas components of galaxies**.

Ionized gas



Westoby et al. (2012) ApJS, 199, 1

Cold gas kinematics

ALMA: CO rotation curve (Cen A)

Cold gas distribution

ALMA: Dense cold gas (CO) distribution (Antennae)

The Team

R.Demarco (co-PI, UdeC, Chile)
Y. Jaffé (UdeC, Chile)
J. Nantais (UdeC, Chile)
Y. Sheen (UdeC, Chile)
H. Messias (UdeC, Chile)
C. Lidman (AAO, Australia)
M. Hilton (UKZN, SouthAfrica)

A. Rettura (co-PI, JPL-Caltech, CA)
P. Rosati (UFerrara, Italy)
S. Mei (ParisMeudon, France)
M. Huertas-C. (P-Meudon, France)
V. Strazzullo (CEA-Paris, France)
D. Stern (JPL-Caltech, CA)

A new cluster survey with KMOS

- 6 galaxy clusters at $0.83 < z < 1.62$ (>100 galaxies)
- Detect the distribution of the ionized gas via the Hα emission line
- Study the kinematics of the ionized gas
- Directly probe the effect of environment in SF quenching
- Census of Star Formation in the densest environments

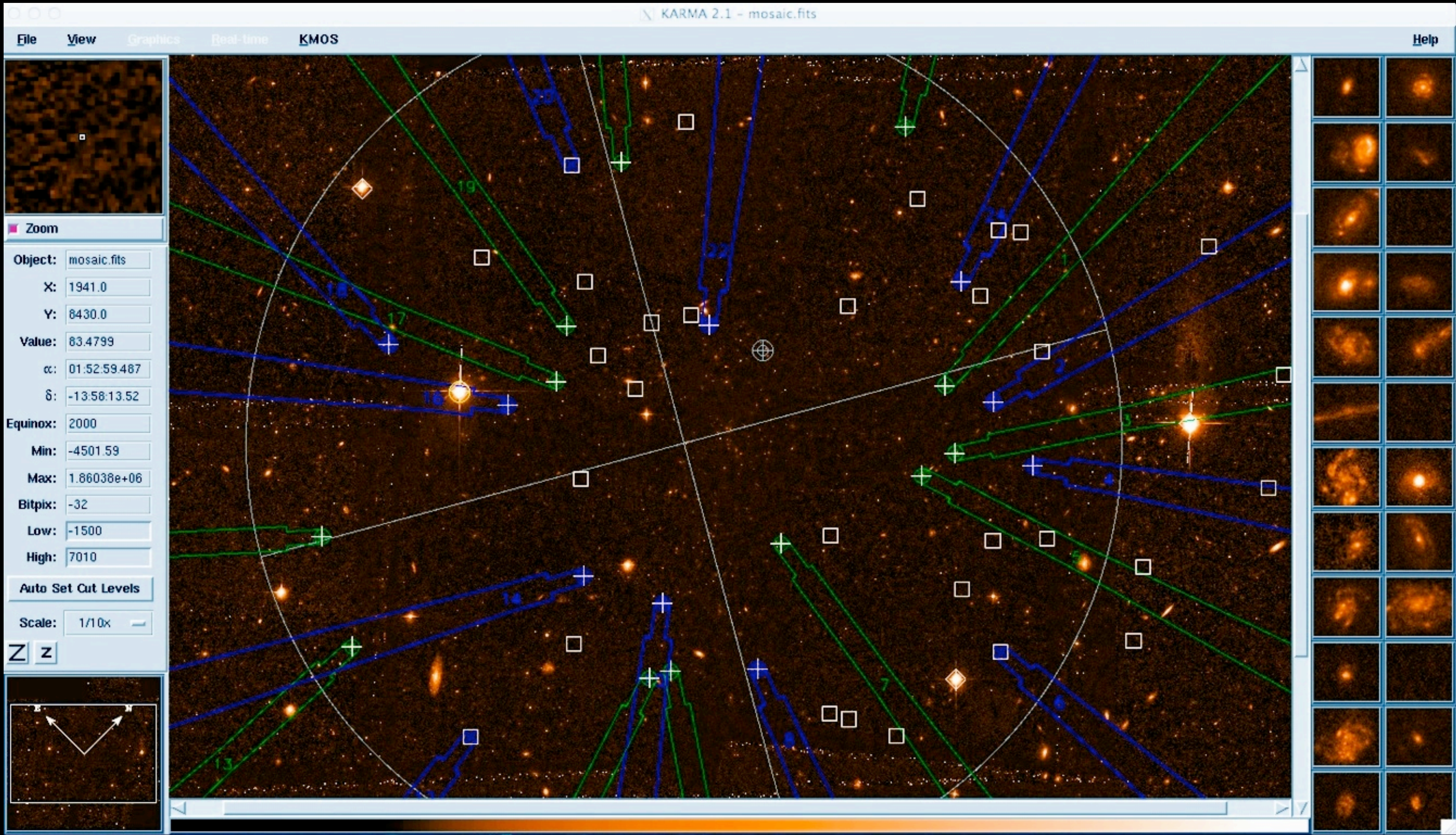
KMOS sample of high-z clusters of galaxies (44 h total)

NAME	REDSHIFT	SELECTION	PHOTOMETRY	SPECTROSCOPY	ESO Period
RX J0152-1357	0.84	X-Ray	ACS/WFC-3, Hawk-I/ISAAC, Spitzer, Chandra, VLA, Herschel	yes (FORS2)	92
XMM J1229+0151	0.98	X-Ray	ACS/WFC-3, Hawk-I/ISAAC	yes	93
RDCS J1252-2927	1.24	X-Ray	ACS/WFC-3 ISAAC, Spitzer, Chandra	yes (FORS2)	93
XMM J2235.3-2557	1.39	X-Ray	ACS/WFC-3, Hawk-I/ISAAC	yes (FORS2)	93
XMM J2215-1738	1.45	X-Ray	ACS/WFC-3, Hawk-I/ISAAC	yes	92
CIG J0218-0510	1.62	IR-Xray	ACS/WFC-3, Hawk-I/ISAAC	yes	92

VLT/KMOS program P.I. (P92, P93): Demarco R. (UdeC, Chile)

Hα emission down to a $SFR_{lim} \sim 5 M_{\odot}\ yr^{-1}$ --- S/N=10 $Å^{-1}$

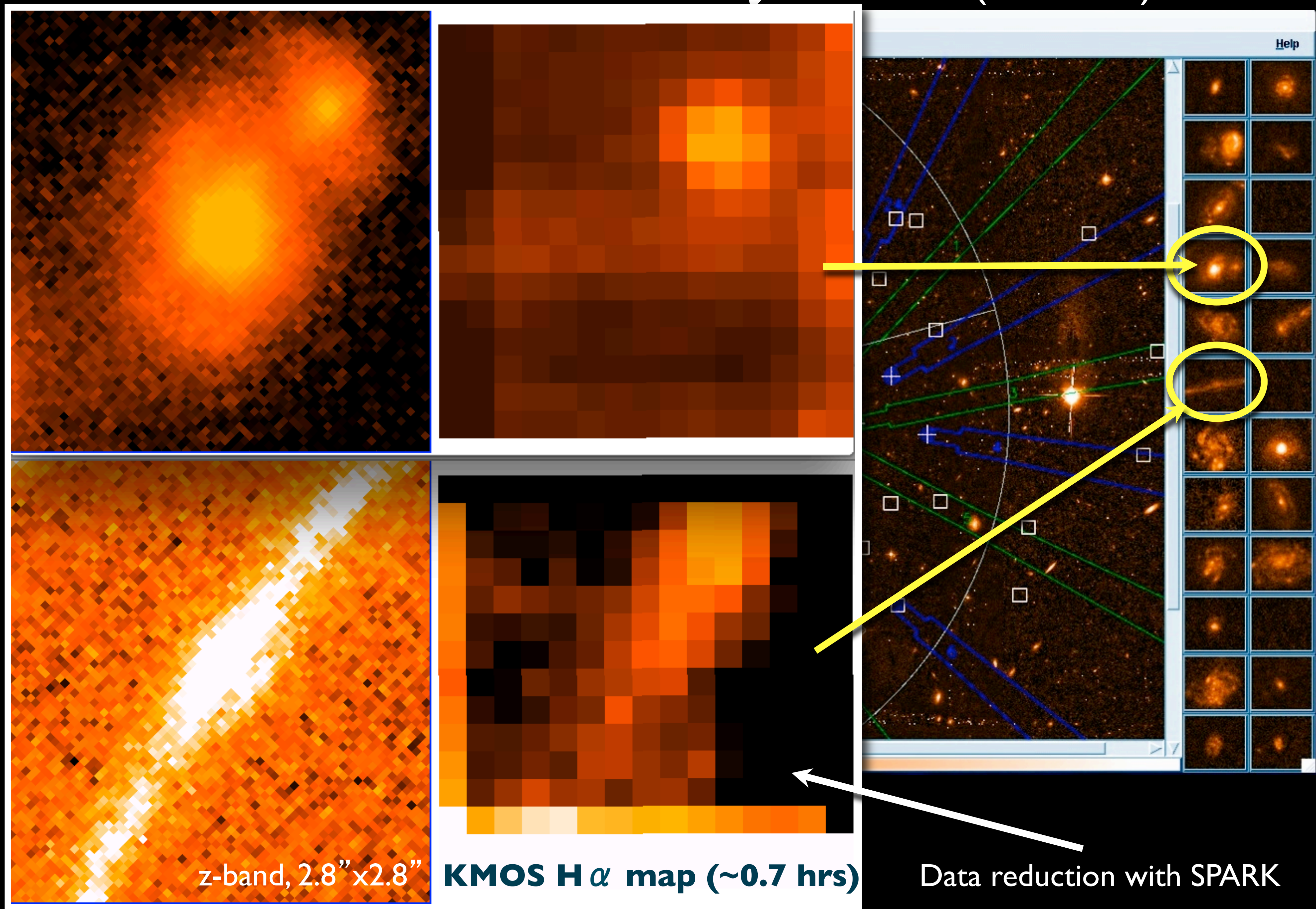
KMOS observations of RXJ0152-13 (z=0.84)



H α within the YJ-band grating

So far: 1/7 OBs observed; 1.0 of 7 hrs

KMOS observations of RXJ0152-13 (z=0.84)



Summary

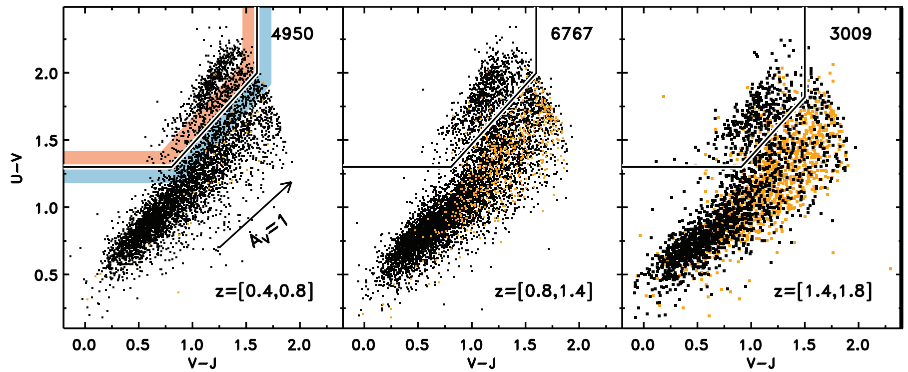
- Work in progress: 2 / 44hrs data taken at Paranal
- IFU observations of High-z cluster galaxies (combined with morphological information and color maps derived from HST),
  will allow us to relate the distribution and kinematics of the ionized gas to the global and local environment in an epoch of increased cosmic star formation.

STAY TUNED…

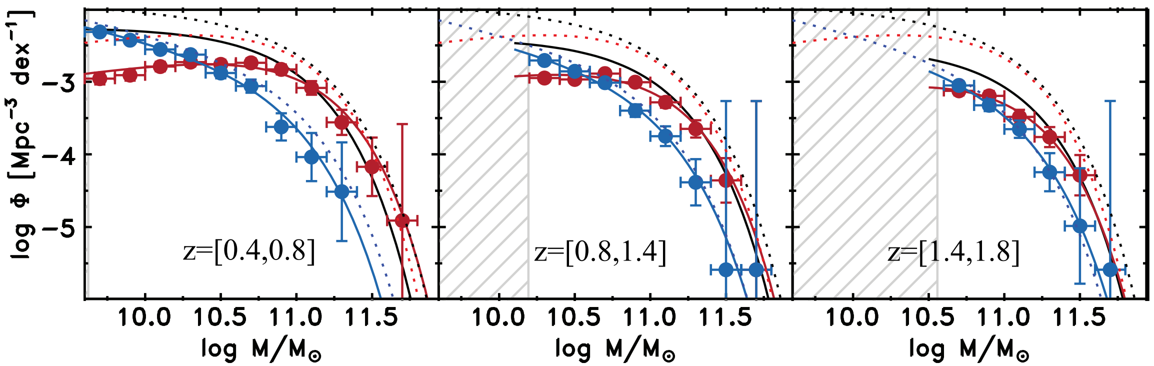
The VIRIAL survey: a deep look at high redshift quiescent galaxies with KMOS

PIs: Trevor Mendel / Roberto Saglia

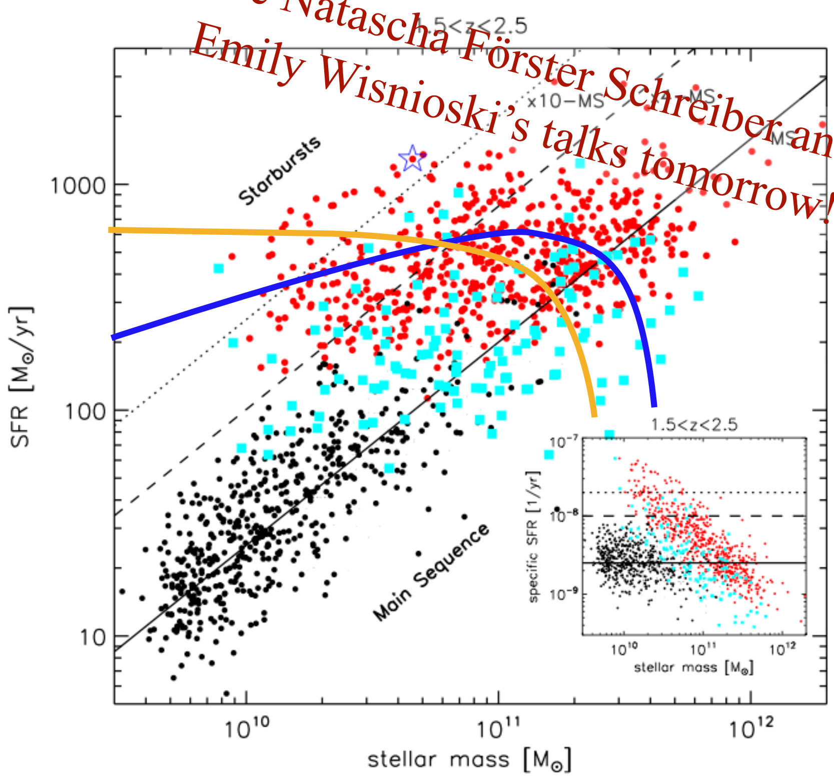
Co-Is: Ralf Bender, David Wilman, Alessandra Beifiori, Jeffrey Chan, Maximillian Fabricius, Matteo Fossati, Sandesh Kulkarni, Stella Seitz, Natascha Förster Schreiber, Stijn Wuyts, Pieter van Dokkum, Gabriel Brammer, Erica Nelson, Ivelina Momcheva



Brammer+2011



See Natascha Förster Schreiber and Emily Wisnioski's talks tomorrow!



Rodighiero+2011

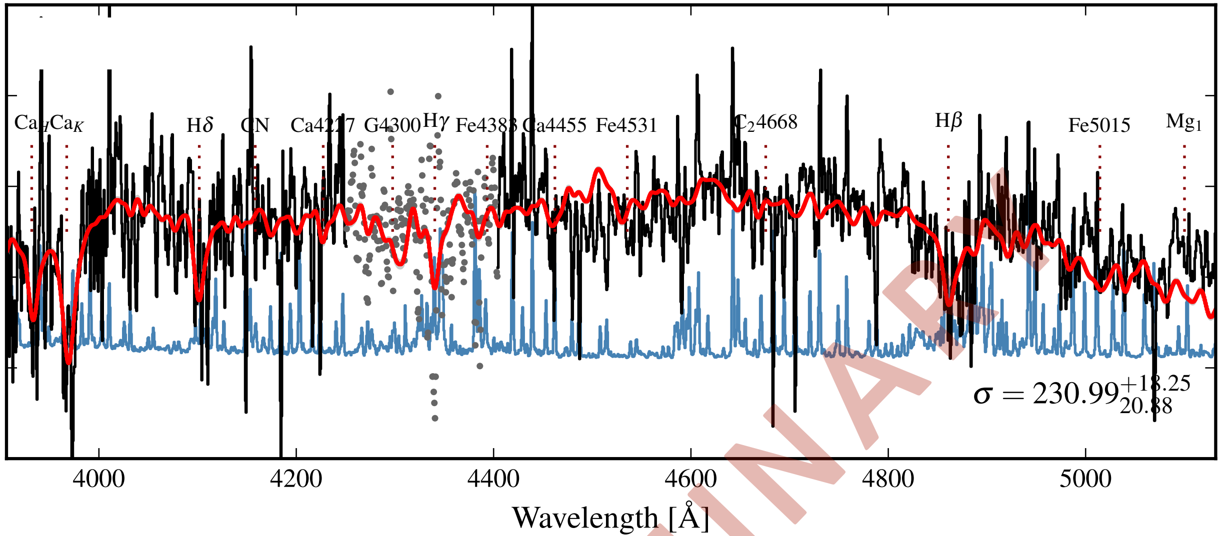
KMOS works (well!)

- Pilot observations of massive (~10^{11} solar mass) galaxies during P92
- 8 hours on source

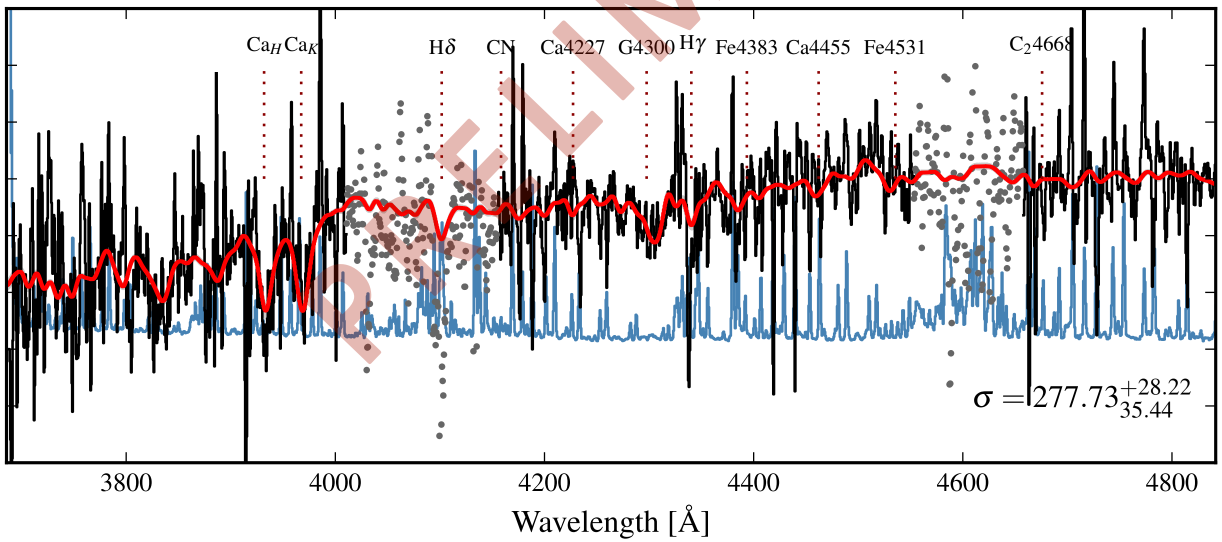
controlling systematic effects:

- illumination
- sky subtraction
- continuum levels

z=1.61

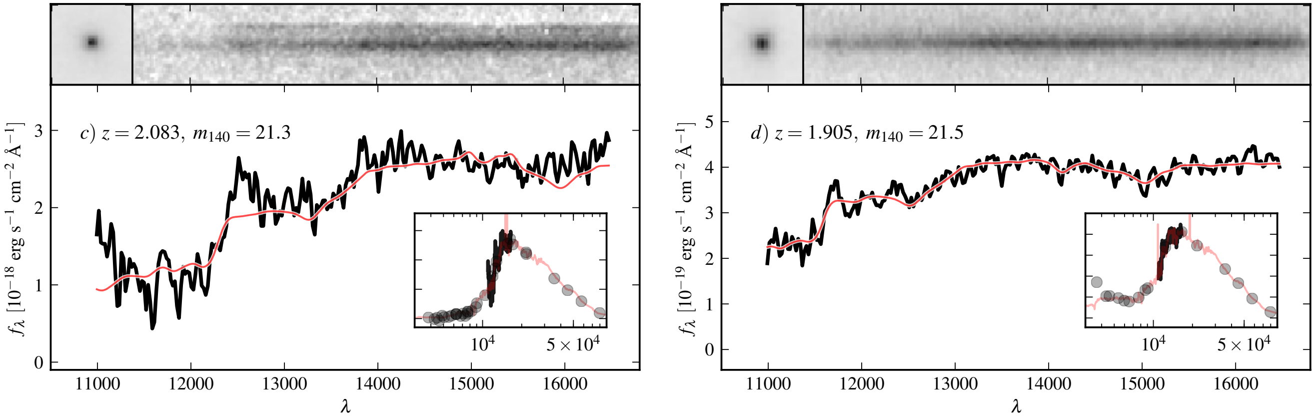


z~1.76



VIRIAL: the VLT IR IFU Absorption Line survey

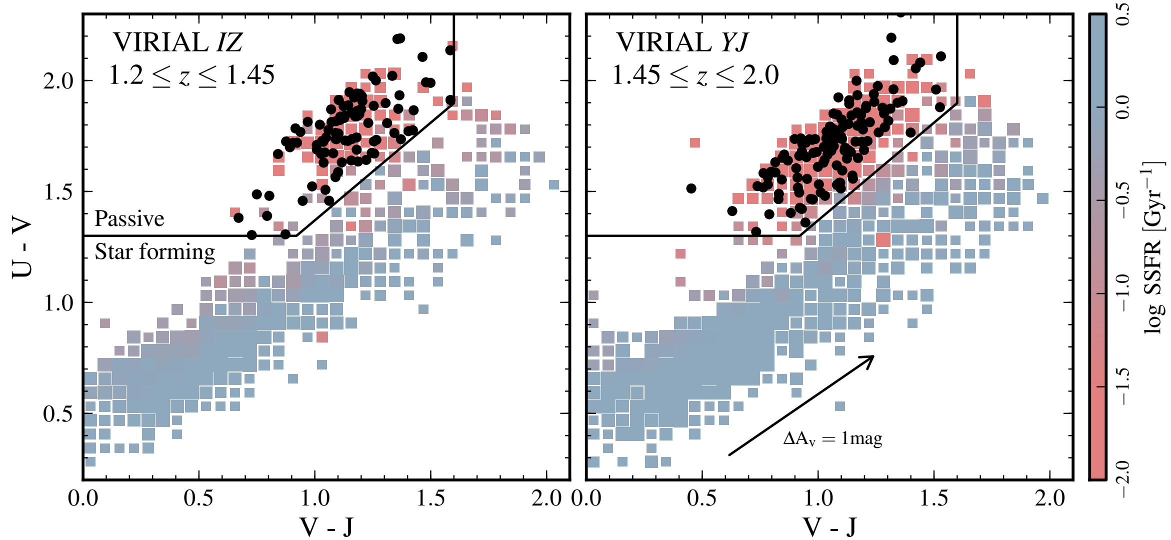
- Selected using NIR grism spectroscopy
- UVJ colour-colour selection identifies quiescent galaxies at 1 < z < 2



Brammer+2012

200 UVJ passive galaxies at z > 1.2

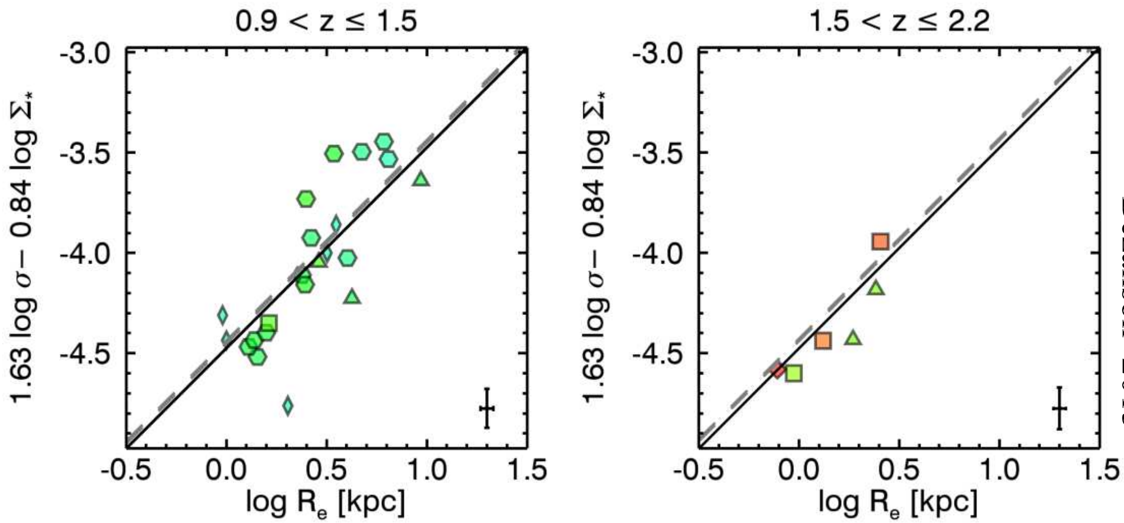
~10-15 sources per KMOS pointing



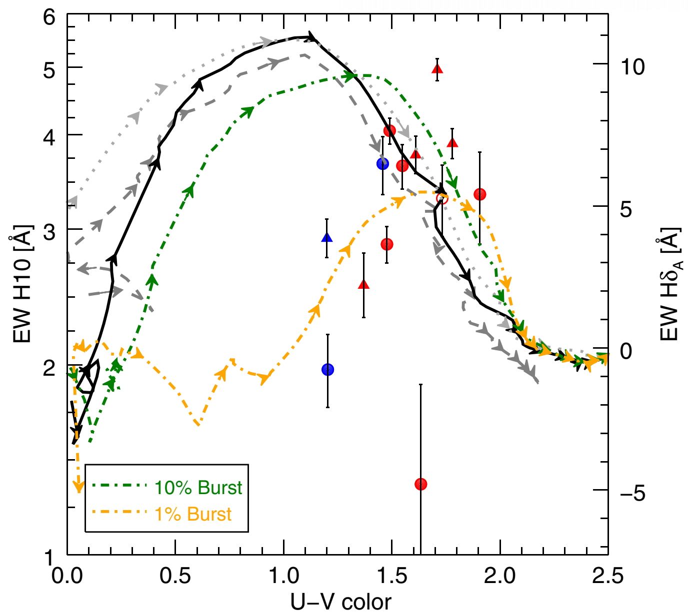
Science goals

Move to an era of less biased high redshift ETG surveys (rather than pointed observations of the brightest/most massive systems)

- fill out “known” scaling dynamical relations (Faber Jackson, FP)
- Constrain star-formation histories using Balmer/metal lines



Bezanson+2013



Bezanson+2013

See Alessandra Beifiori’s KMOS talk tomorrow!

KMOS Cluster project: V-band stellar populations at z=1.5

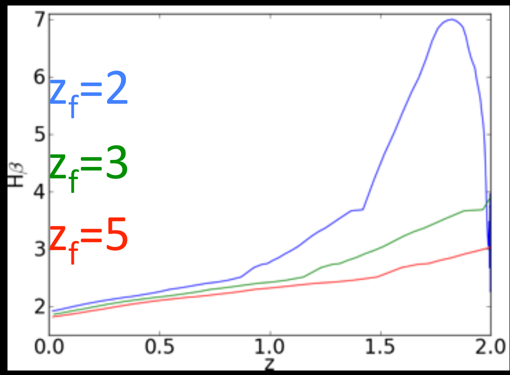
Trevor Mendel (on behalf of Ryan Houghton)

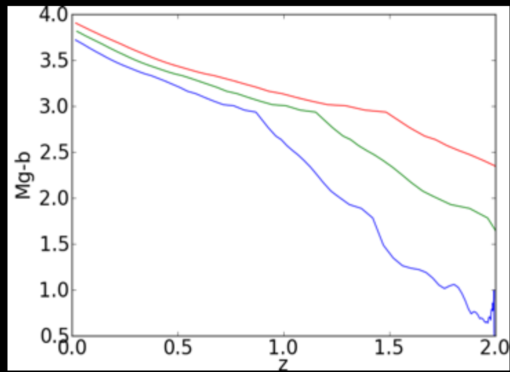
PIs: Roger Davies (Oxford) / Ralf Bender (MPE)

Co-Is: Alessandra Beifiori, Jeffrey Chan, David Wilman, Roberto Saglia, Russell Smith, John Stott, Michele Cappellari

Quick Intro

- Stars in local cluster ETGs formed 6-10 Gyrs ago (1 < z < 2) – Sanchez-Blazquez+06,09; Trager+08; Houghton+12
- What stopped the SF? What conditions did stars form in?
- NIR gives rest frame V-band at z ~ 1.5
  - Derive stellar composition from well understood spectral features, before low-z star formation, size evolution & when differences pronounced. Compare directly to low-z (eg Coma).
  - Avoids use of blue indices (Jorgensen+05,Barr+05)
- 24 IFUs => 24x longer integration, no slit losses, enabling absorption line spectroscopy





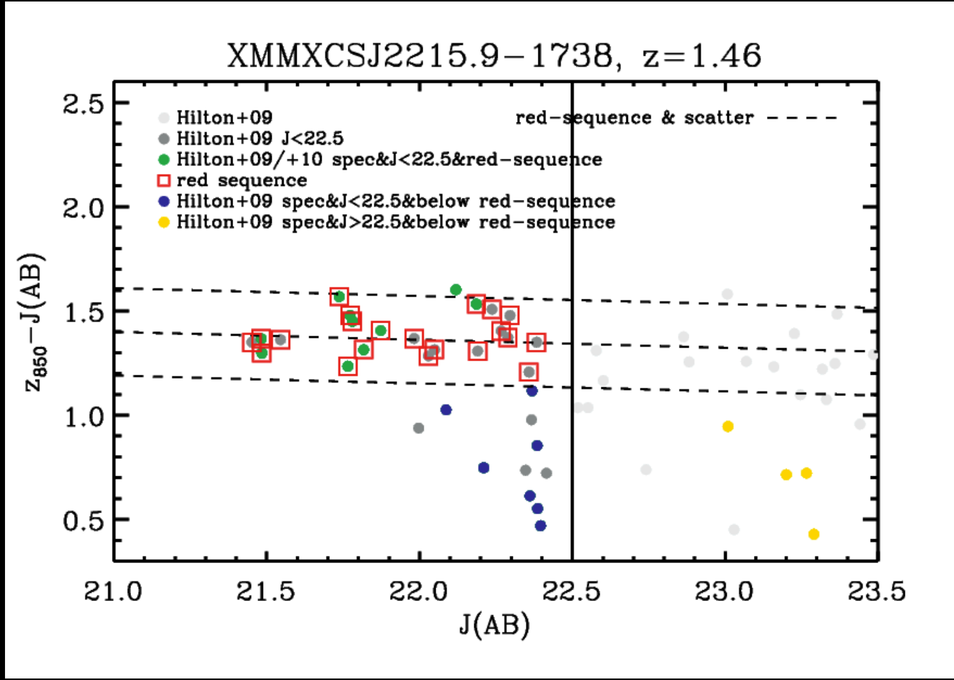
Cluster selection

4 clusters at z>1 based on available HST imaging and atmospheric transmission windows:

- z=1.04 CaH+K to Mgb in one shot (iz)
- z=1.39, z=1.46, z=1.60 (V-band feats. in trans windows)

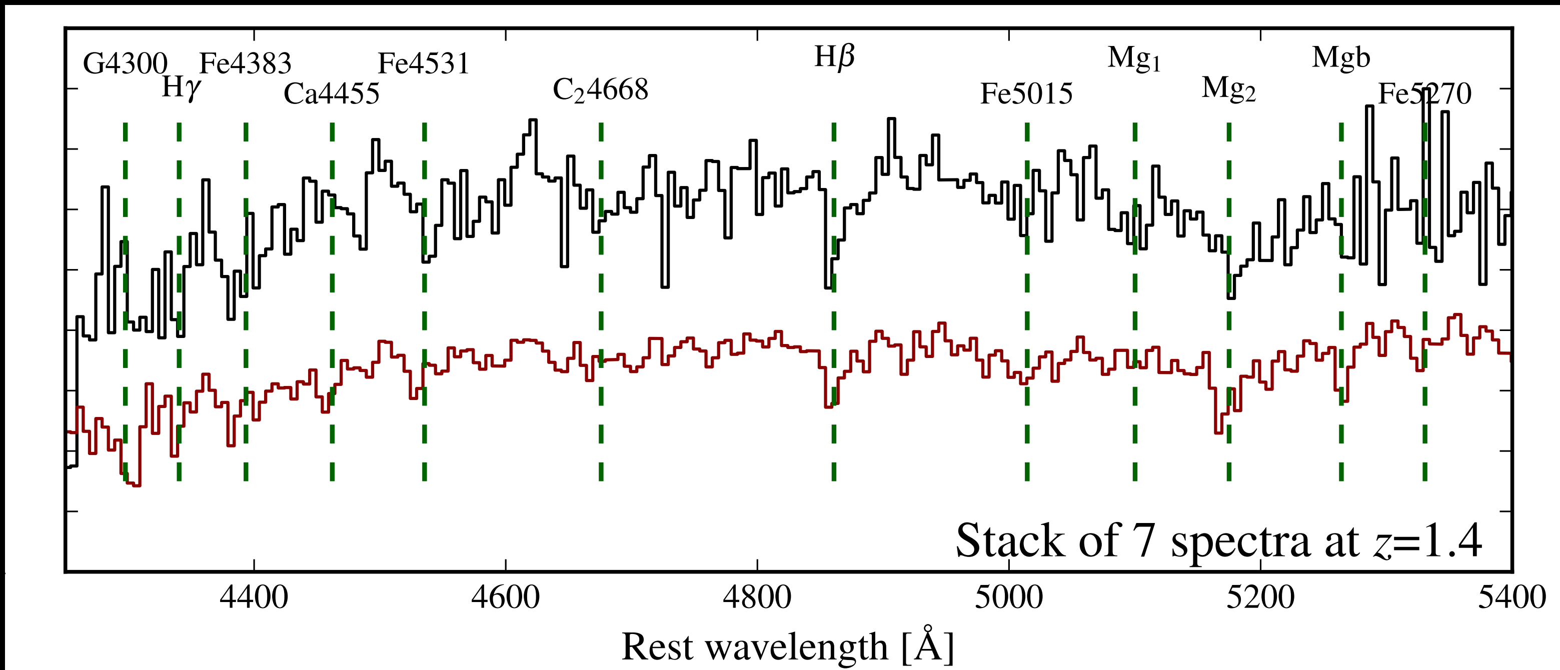
Galaxy selection

- >20 galaxies per cluster with S/N>5 per pixel
- Testing beam switching and OSO modes
- Priorities: red sequence, z-confirmation, mag/mass limit



PRELIMINARY results

- Data reduction still very much in progress
- Pushing background systematics down to the single count level is difficult
- Have to be careful in treating stellar populations (Charlie's talk)

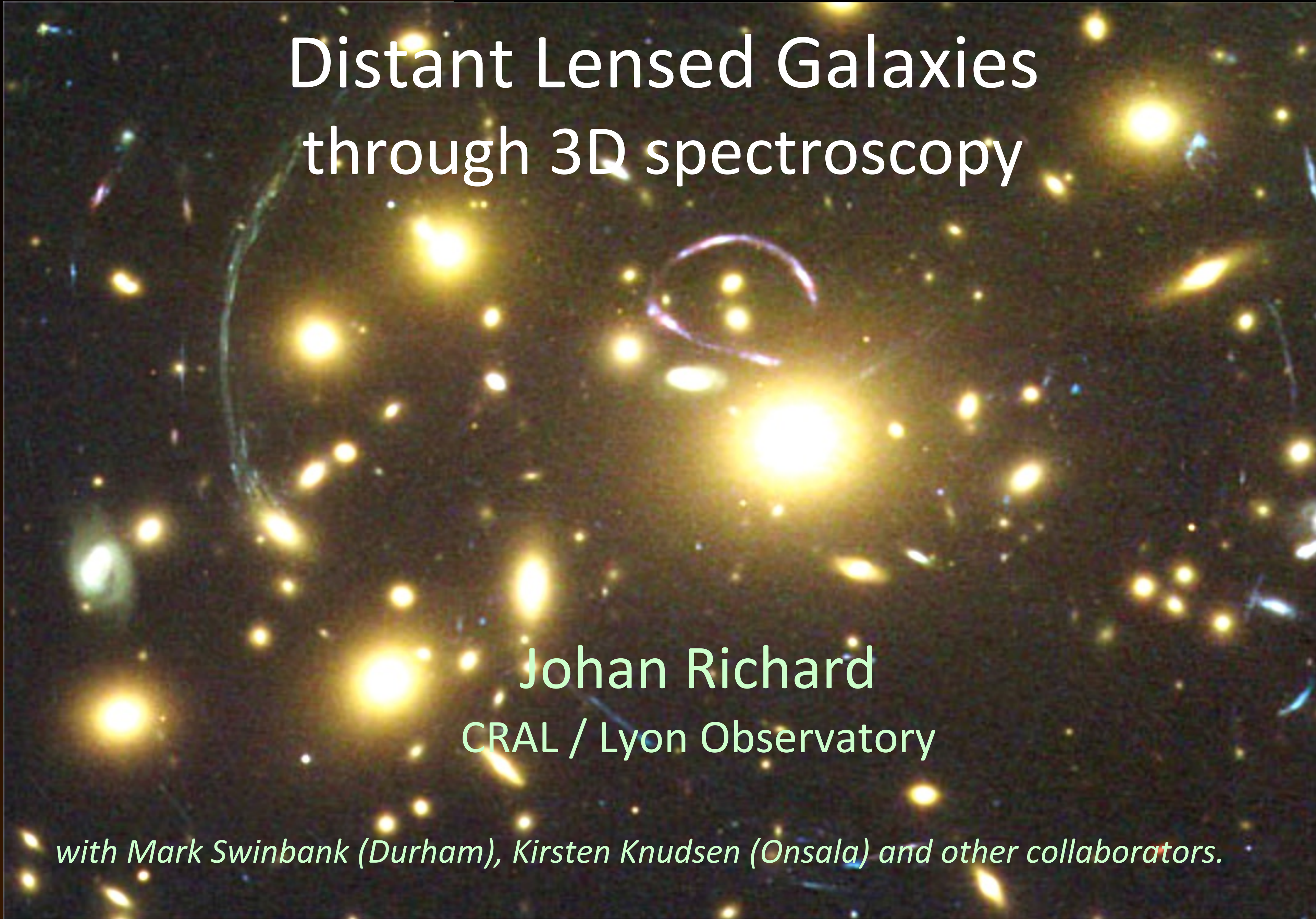


Future

- 4 clusters, >80 cluster galaxies with HST imaging, V-band spectra and kinematics
  - Stellar population studies of V-band indices at z=1.5
    - Ages of cluster galaxies before dilution
      - Coeval or dispersed formation?
      - Global or isolated quenching ?
    - Abundances: Fe and Mg measurements
      - Star formation timescales and enrichments
  - Compare dynamical and stellar population masses
    - DM / IMF constraints?

See Alessandra Beifiori's talk tomorrow!

3D2014 Gas and stars in galaxies: A multi-wavelength 3D perspective



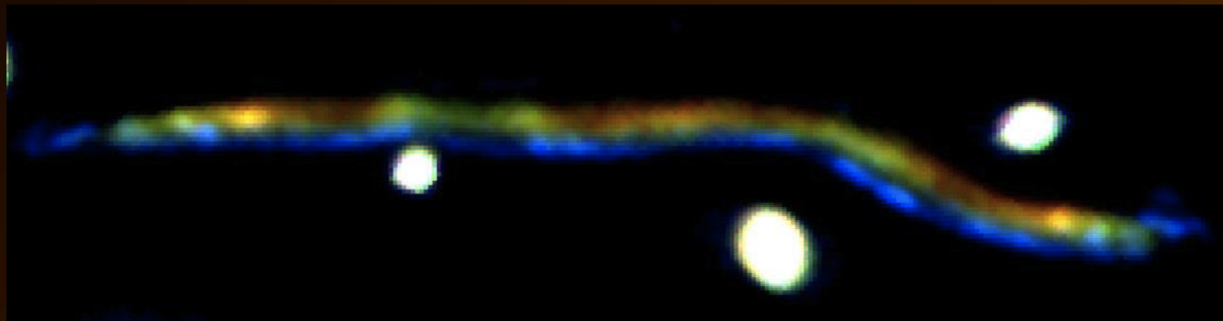
Distant Lensed Galaxies through 3D spectroscopy

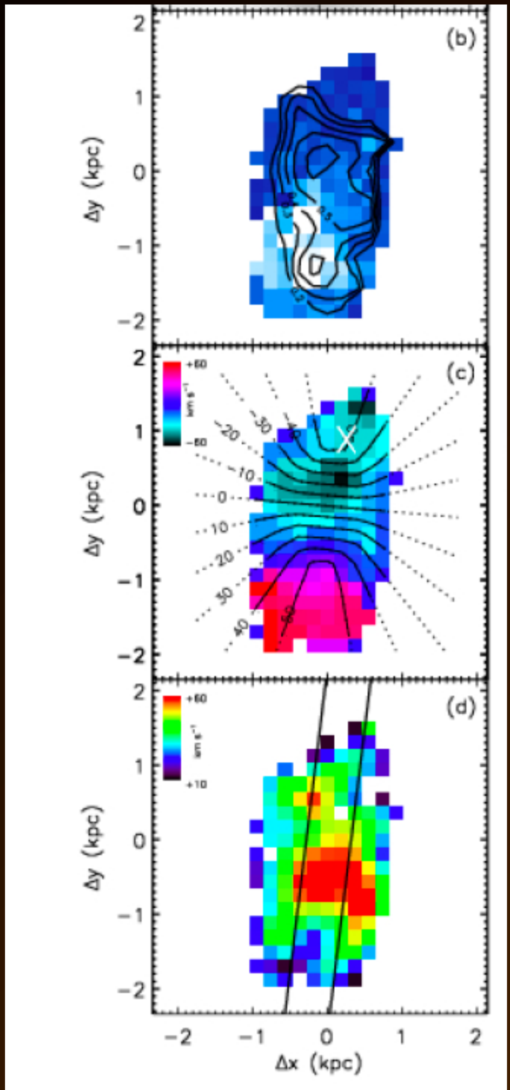
Johan Richard

CRAL / Lyon Observatory

with Mark Swinbank (Durham), Kirsten Knudsen (Onsala) and other collaborators.

Lensing clusters + IFUs

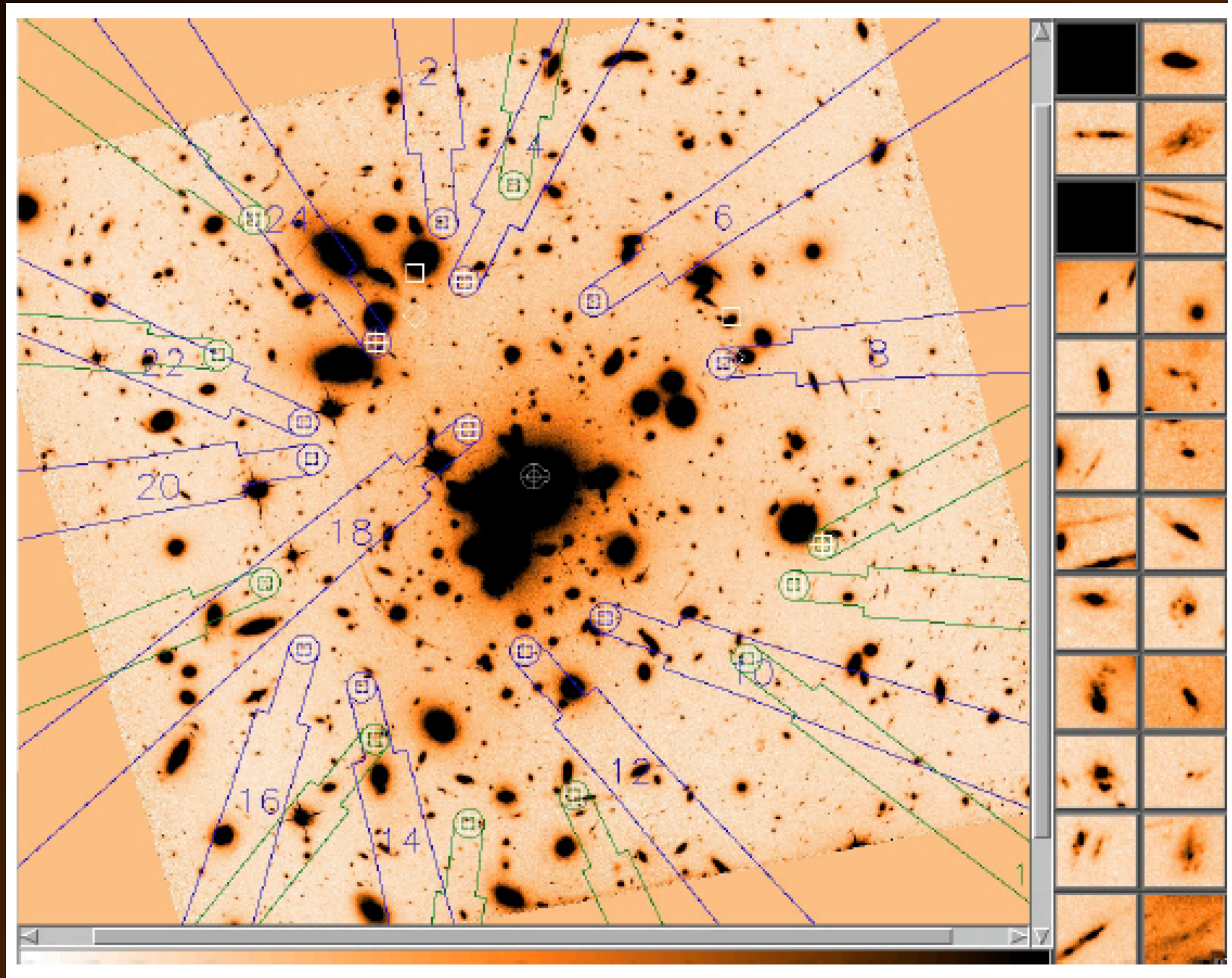




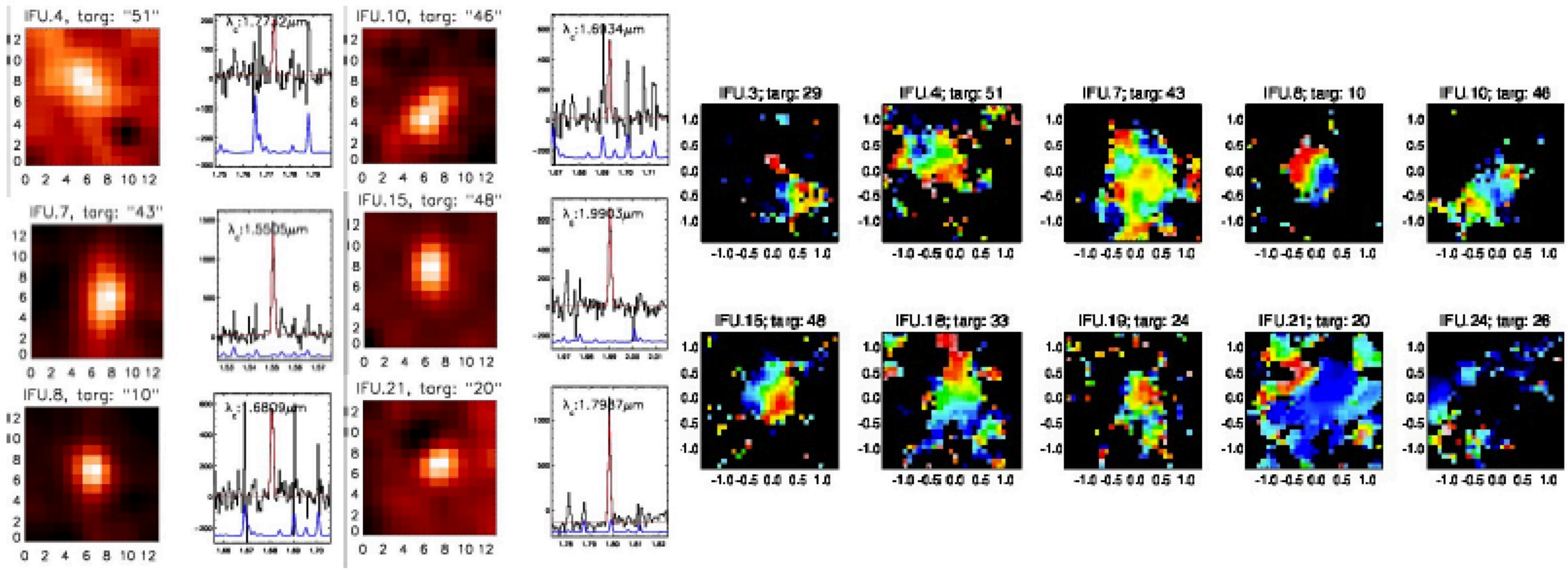
- Typical magnifications reach > 10 or more near the centre of lensing clusters, with an improved spatial resolution
- Combining lensing clusters and IFUs is the best way to measure resolved properties (dynamics, chemical abundances, SF regions) in ~ 10^8 Msol galaxies
- A good knowledge of the cluster mass distribution is needed to measure and correct the lensing effects.

KMOS-SV

2.25 hours on lensed galaxies behind Abell 1689



KMOS-SV results

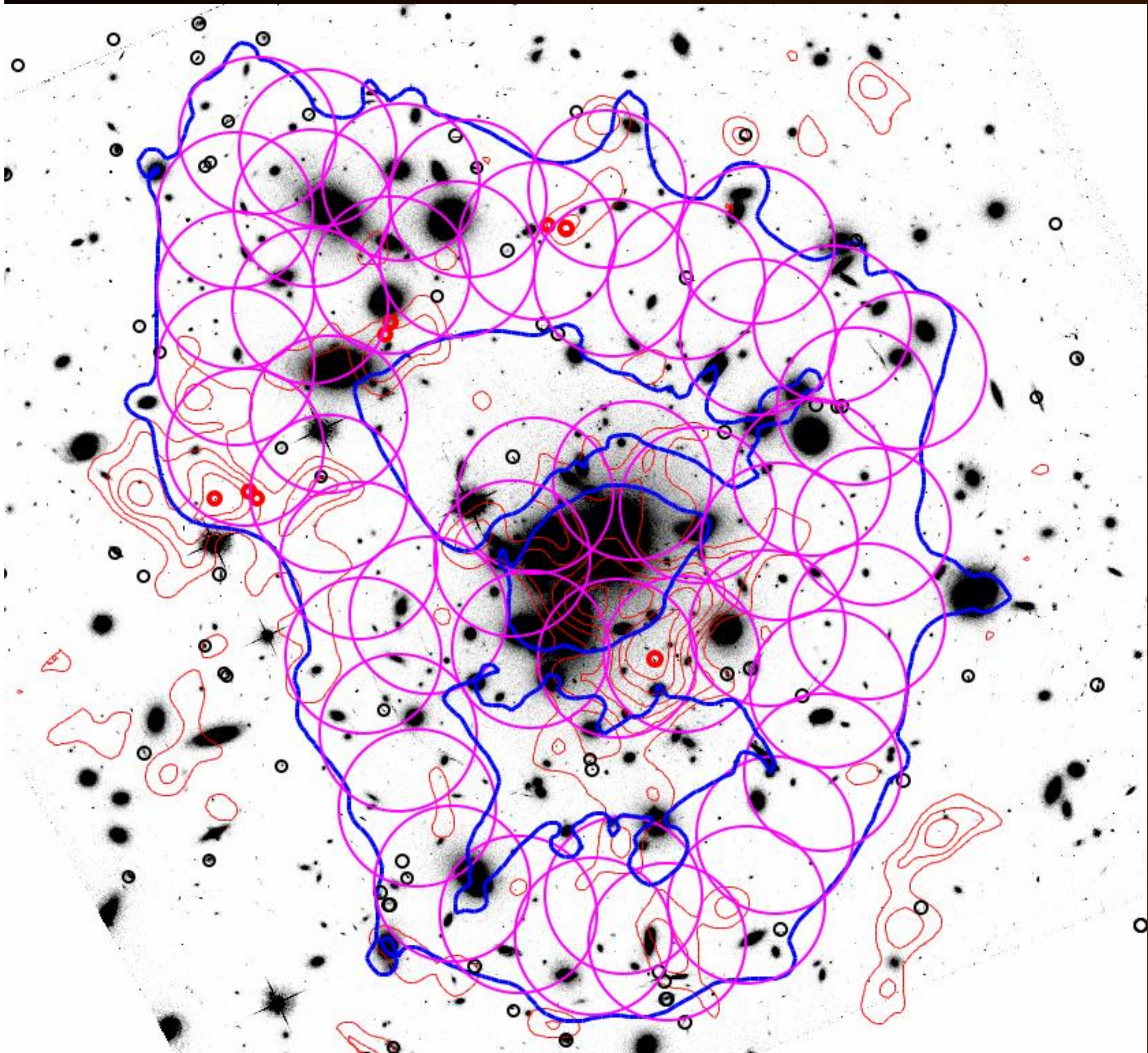


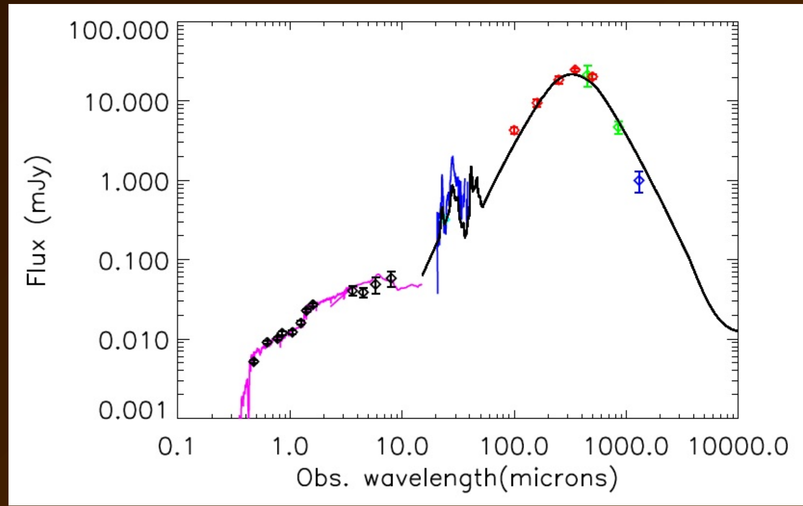
- Measurements of SFR, metallicities and gas dynamics in 10^8 Msol. stellar mass galaxies through nebular lines at 1<z<5
- MUSE test observations of the same field: outflows

New program (P93): 4 hours on Abell 2744 and AS1063 to follow-up multiple images at 0.8 < z < 5

ALMA-cycle 0 program

~ 50 pointings covering the high magnification region at 1.3 mm, total time 6.7 hours reaching 0.5 mJy per pointing in the continuum (4σ)





- Deep 1.3mm continuum image, 1 mJy LIRG @ z=2.6

- Stacked CO lines for 30 low-luminosity galaxies at known 1.5<z<3.0

#19

The characteristics of dusty starburst galaxies in the proto-cluster around radio galaxy 4C23.56 at z = 2.48 revealed by JVLA

Minju Lee
(The University of Tokyo/ NAOJ)

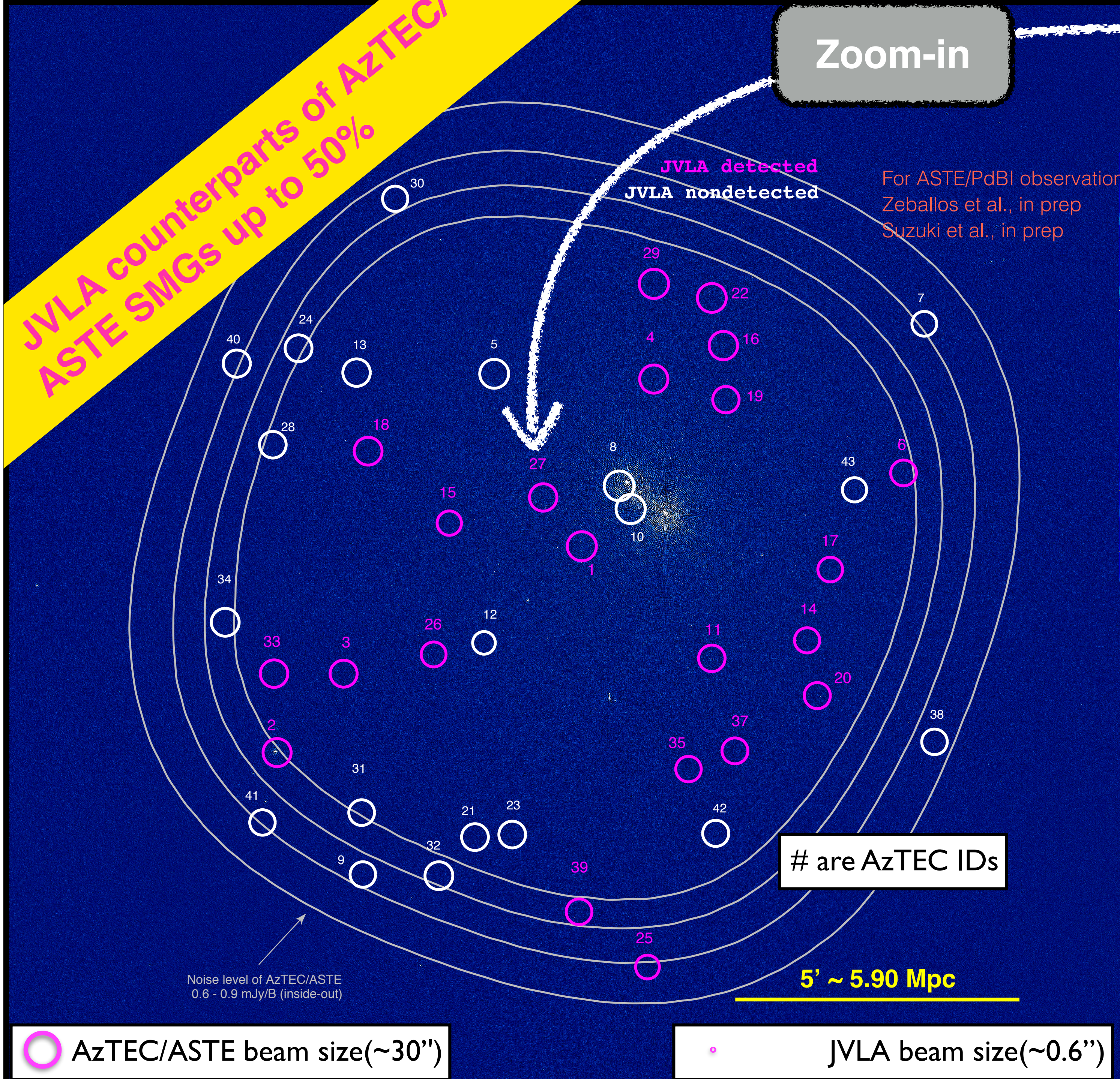
Collaborators : Ryohei Kawabe, Daisuke Iono, Kotaro Kohno, Yoichi Tamura, Kenta Suzuki, Bunyo Hatsukade, Kouichiro Nakanishi, Tadayuki Kodama, Seiji Kameno, Ichi Tanaka, Kenichi Tadaki, Soh Ikarashi, Junko Ueda, Hideki Umehata, Toshiki Saito

Backgrounds :

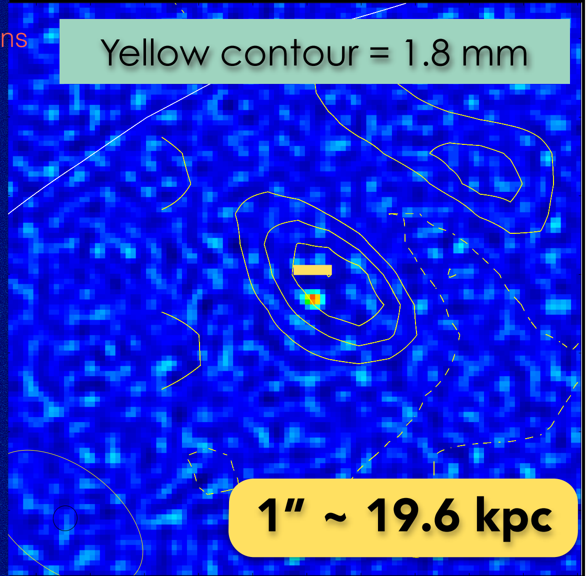
Environmental effects in massive galaxy formation in high redshift — high dense region of protocluster

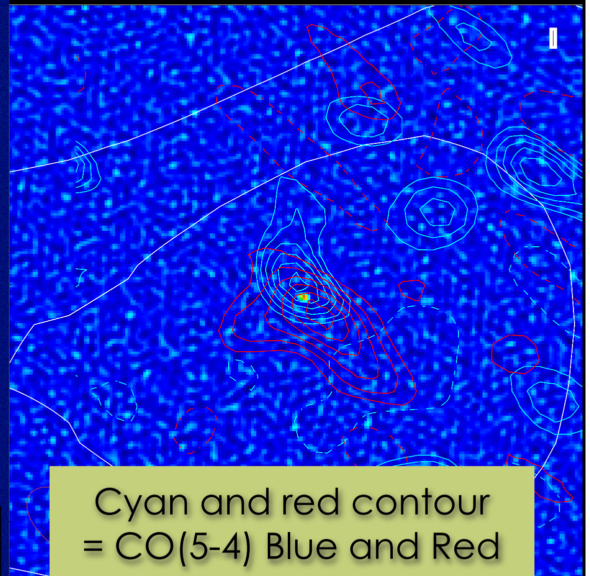
A case study : Protocluster surrounding 4C23.56

JVLA counterparts of AzTEC/ ASTE SMGs up to 50%



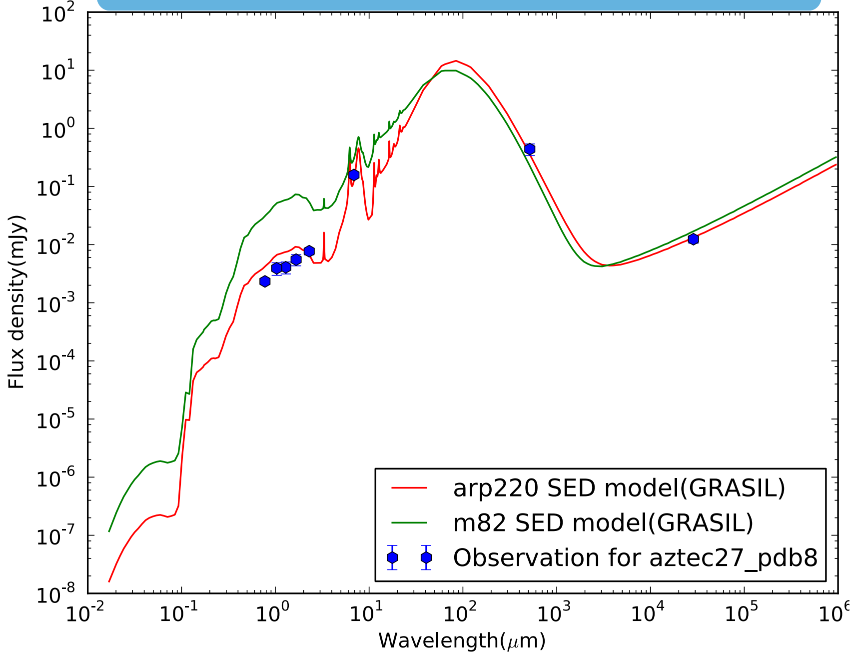
JVLA detection of AzTEC27 - PdB8



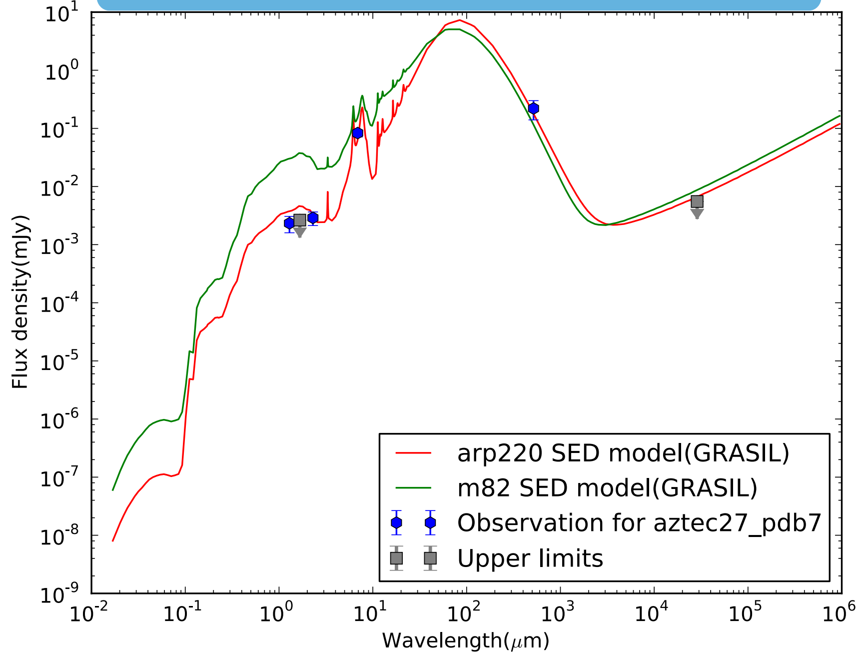


SED model fitting

AzTEC27-PdB8 SED fitting



AzTEC27-PdB7 SED fitting



AzTEC 27	PdB8	PdB7
SFR(HAE) ($L_\odot$/yr)	110	310
Sv(1.8 mm) (μJy)	440±100	220±80
$L'_{CO(5-4)}$ (10^{10} K km s^{-1} pc^2)	6.20	4.33
$\nu_{CO(5-4)}$ (GHz)	165.0	165.6
ΔV (km/s)	910	215
Sv(3 GHz) (μJy)	12.4	< 5.52

Future works in progress and scheduled

1. Source counts of 3 GHz in the field of 4C23.56
2. The redshift distribution of sources around 4C23.56, and SMG association to the protocluster
3. Future observations scheduled at high spatial/spectral resolution with ALMA and JVLA

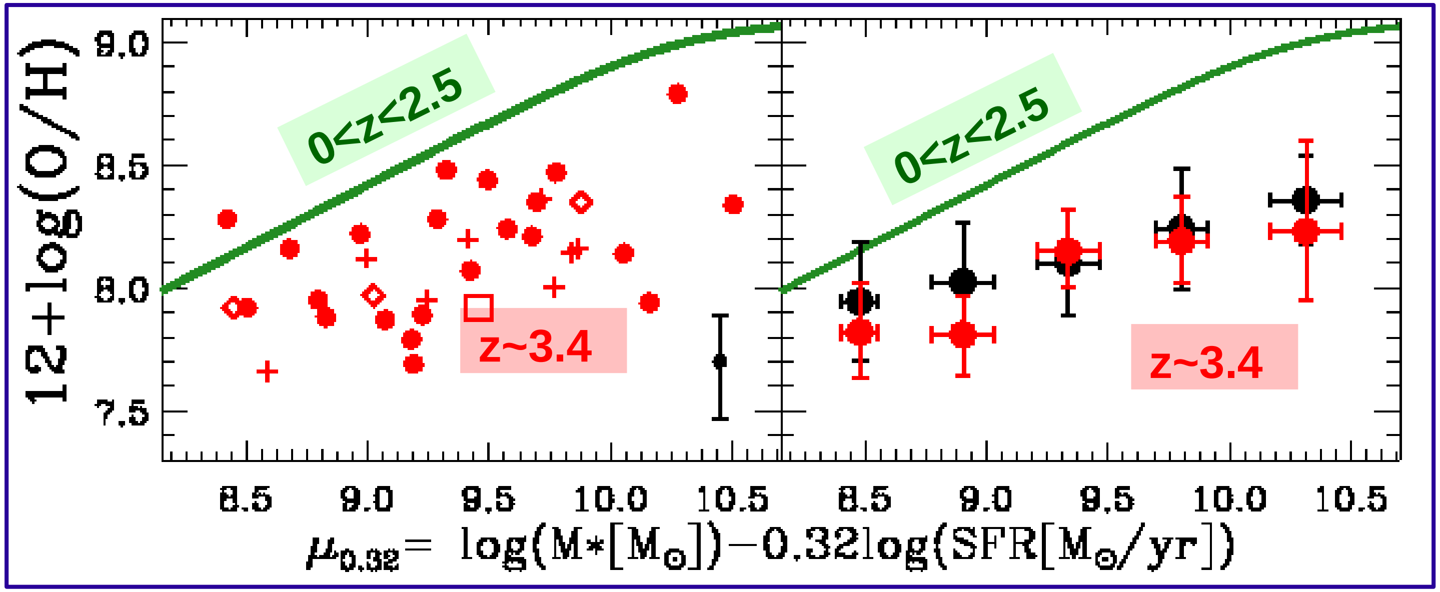
Please come to poster #19 and talk with me!

Metallicity evolution, metallicity gradients, and gas fractions at z~3.4 "AMAZE & LSD"

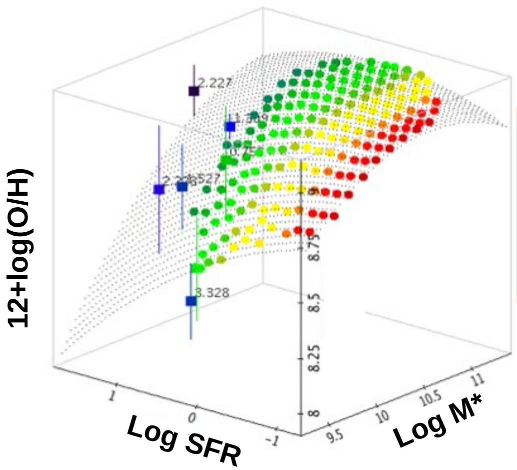
P. Troncoso, R. Maiolino,
V. Sommariva, G. Cresci, F. Mannucci,
A. Marconi, M. Meneghetti, A. Grazian, A. Cimatti, A. Fontana,
T. Nagao, L. Pentericci

A&A 563, A58 (2014)

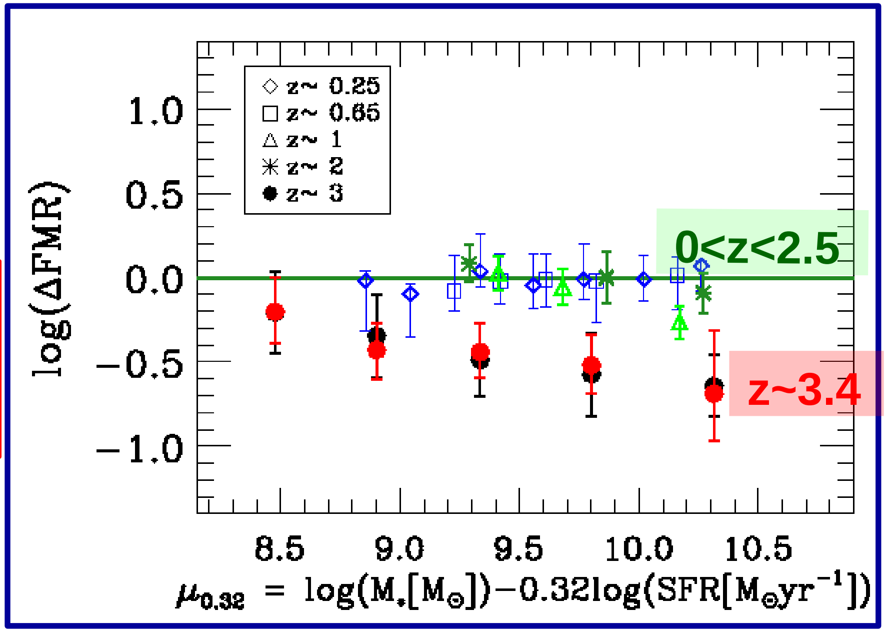
LBGs at z~3 are metal poorer than lower-z galaxies of the same M_* and SFR



- Change on SF efficiency at z~3? Strong feedback by UV field & SNe?
- Mergers?
- Pristine gas excess?



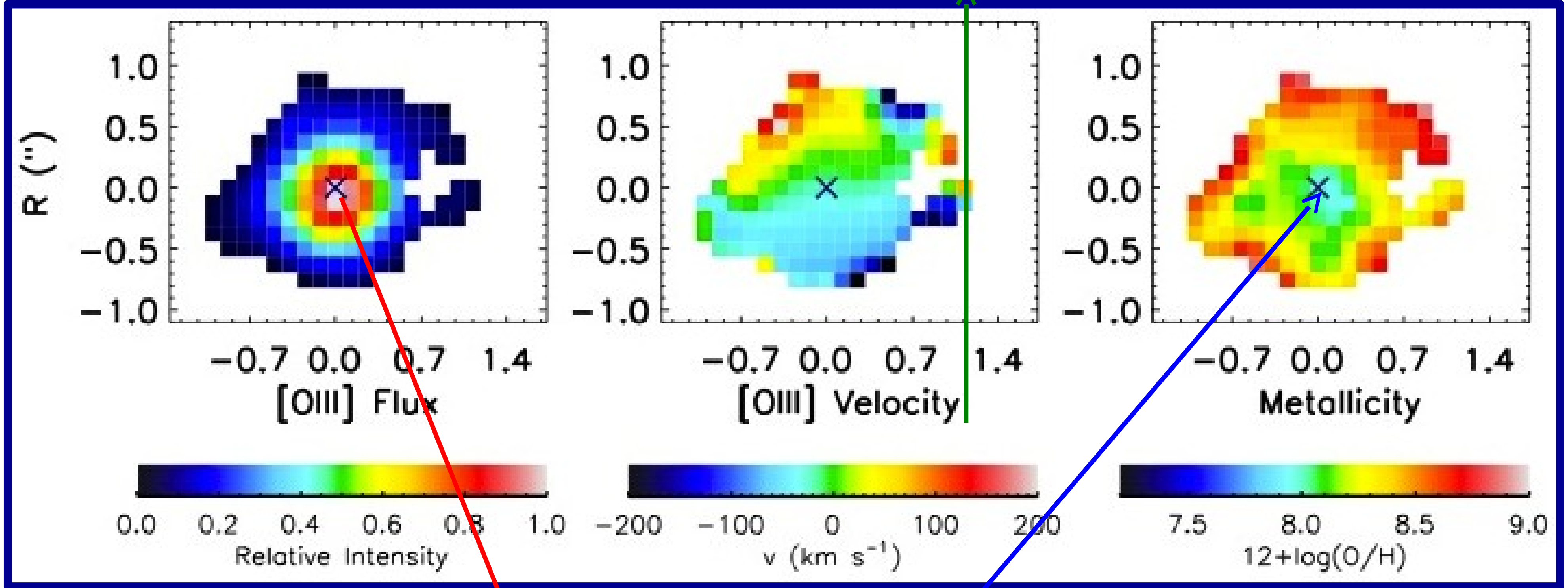
Massive, low-SFR galaxies present higher deviation respect to FMR.



P. TRONCOSO, ESO-3D2014

Spatial anticorrelation between metallicity and SFR

Massive rotating disk

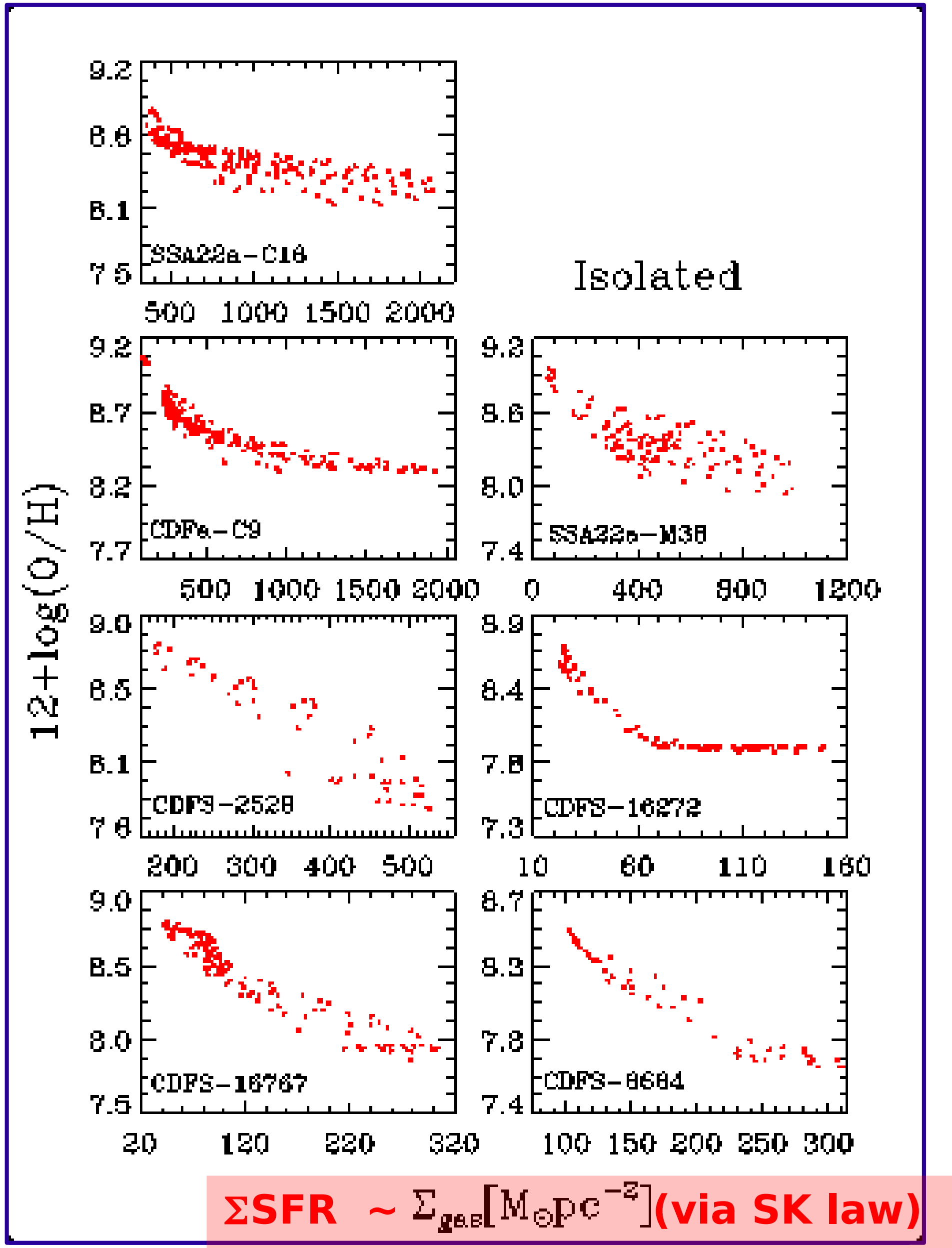


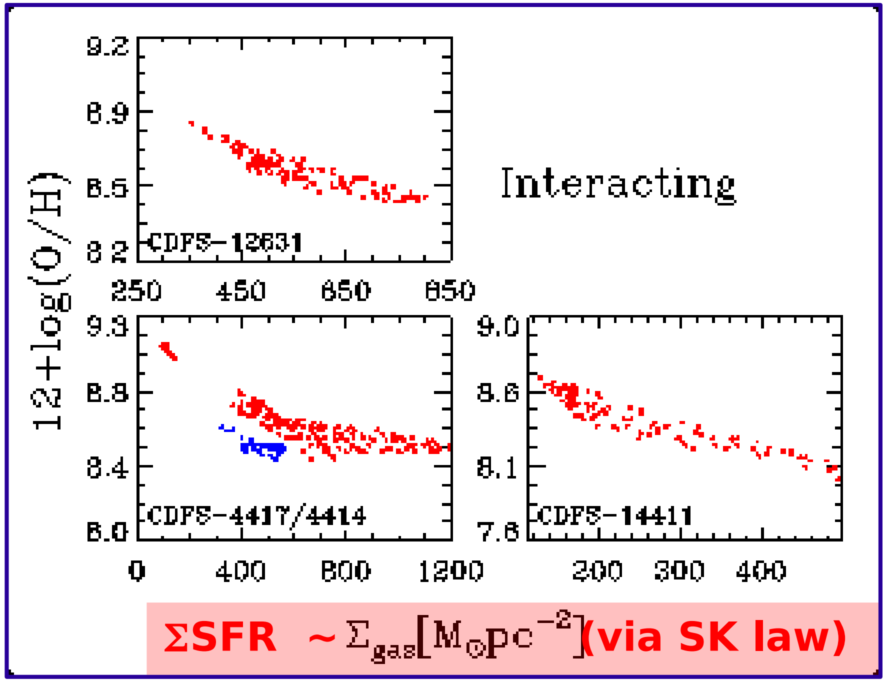
Peak of star formation is spatially correlated with the **minimum of metallicity**

Likely due to prominent inflows of pristine gas which boost the star formation but also dilute the metals.

Cresci et al.10
Gnerucci et al. 11
Troncoso et al. 14

Spatial anticorrelation between metallicity and ΣSFR





Surface star formation rate anticorrelates with metallicity. Likely due to prominent inflows of pristine gas which ***boost the star formation*** *but* ***also dilute the metals.***