Science with multi object IFUs on ULTIMATE

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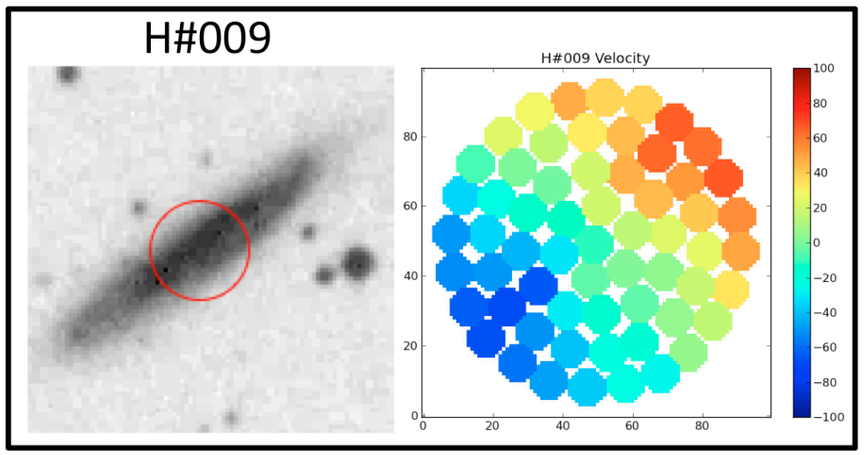
SAMI and the SAMI Galaxy Survey

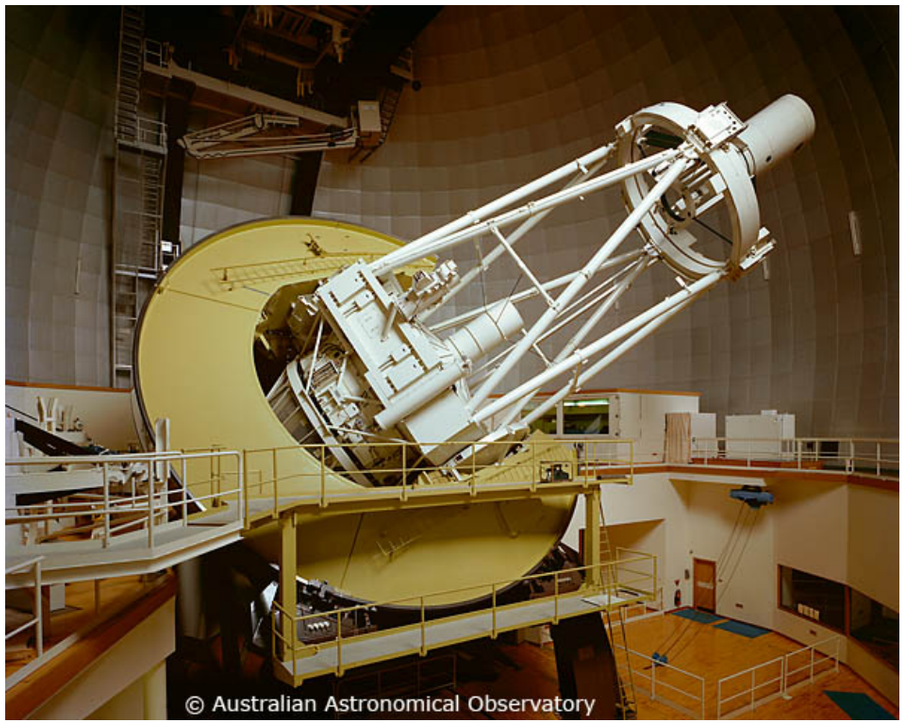
The Sydney-AAO Multi-object Integral field spectrograph

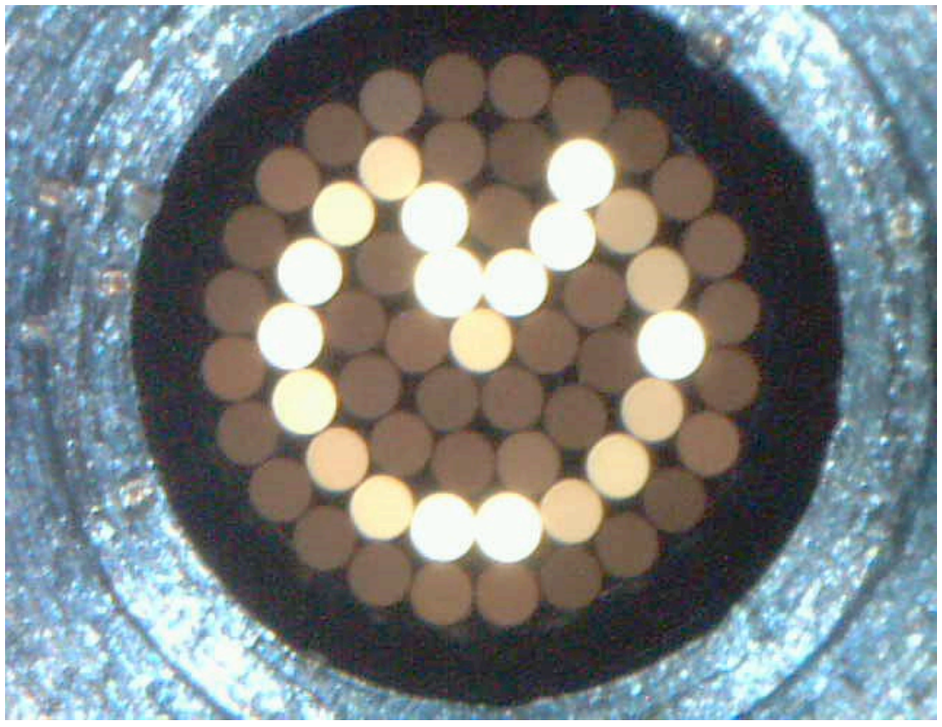
PI Scott Croom



The SAMI Instrument

- Located at the prime focus of the AAT
- 1 degree diameter f-o-v.
- 13 x 61 fibre IFUs using hexabundles (Bryant, Bland-Hawthorn et al.).
- 15” diameter IFUs, 1.6” diameter fibre cores.
- 26 separate sky fibres
- Feeds AAOmega, a bench mounted optical spectrograph (42m fibre cable)
- Spectral resolution R~1700 (blue), R~4500 (red).





SAMI key science topics

› **What are the physical processes responsible for galaxy transformations?**

- Morphological and kinematic transformations; suppression of star formation; internal vs. external; secular vs. fast; ram pressure stripping; harassment, strangulation; galaxy–group/cluster tides; galaxy-galaxy mergers; galaxy-galaxy interactions…

› **How does mass and angular momentum build up?**

- The galaxy velocity function; stellar mass in dynamically hot and cold systems; galaxy merger rates; halo mass from velocity-field shear; Tully-Fisher relation…

› **Feeding and feedback: how does gas get into galaxies, and how does it leave?**

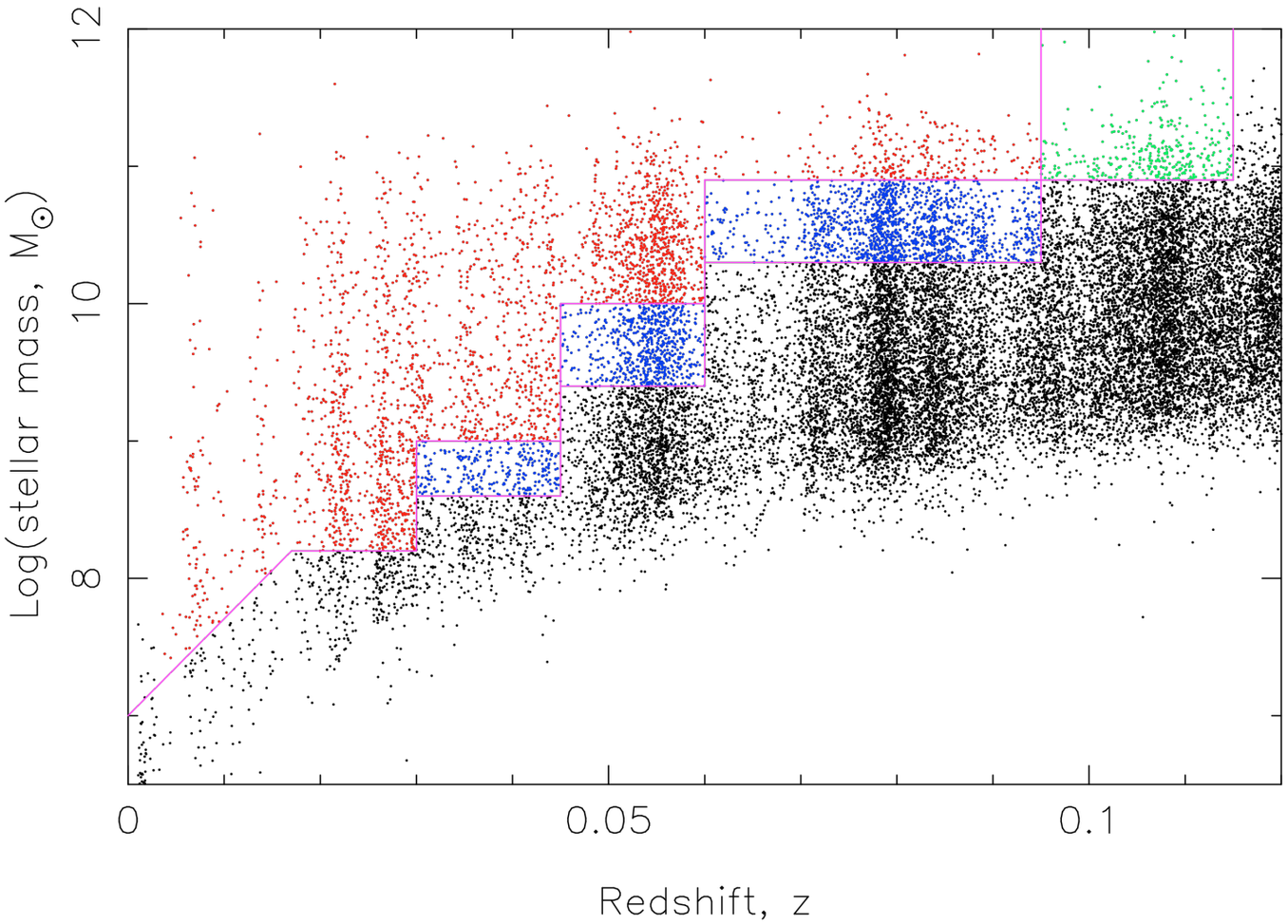
- Winds and outflows; feedback vs. mass; triggering and suppression of SF; gas inflow; metallicity gradients; the role of AGN…
- Important synergies with ASKAP HI surveys.

The SAMI survey

› Started in March 2013.
› 3400 galaxies in ~200 nights, 4 hours exposure per field.
› Primary fields are the Galaxy And Mass Assembly (GAMA) regions.
- Three 4x12 deg equatorial regions at 9hr, 12hr and 15hr RA.
- Deep, complete, spectroscopy to r=19.8 to define environment.
- Robust group catalogue (Robotham et al. 2011).
- GALEX, SDSS, VST, UKIDSS, VISTA, WISE, Herschel imaging.
- HI 21cm from ALFALFA (half the area), and in the future ASKAP.

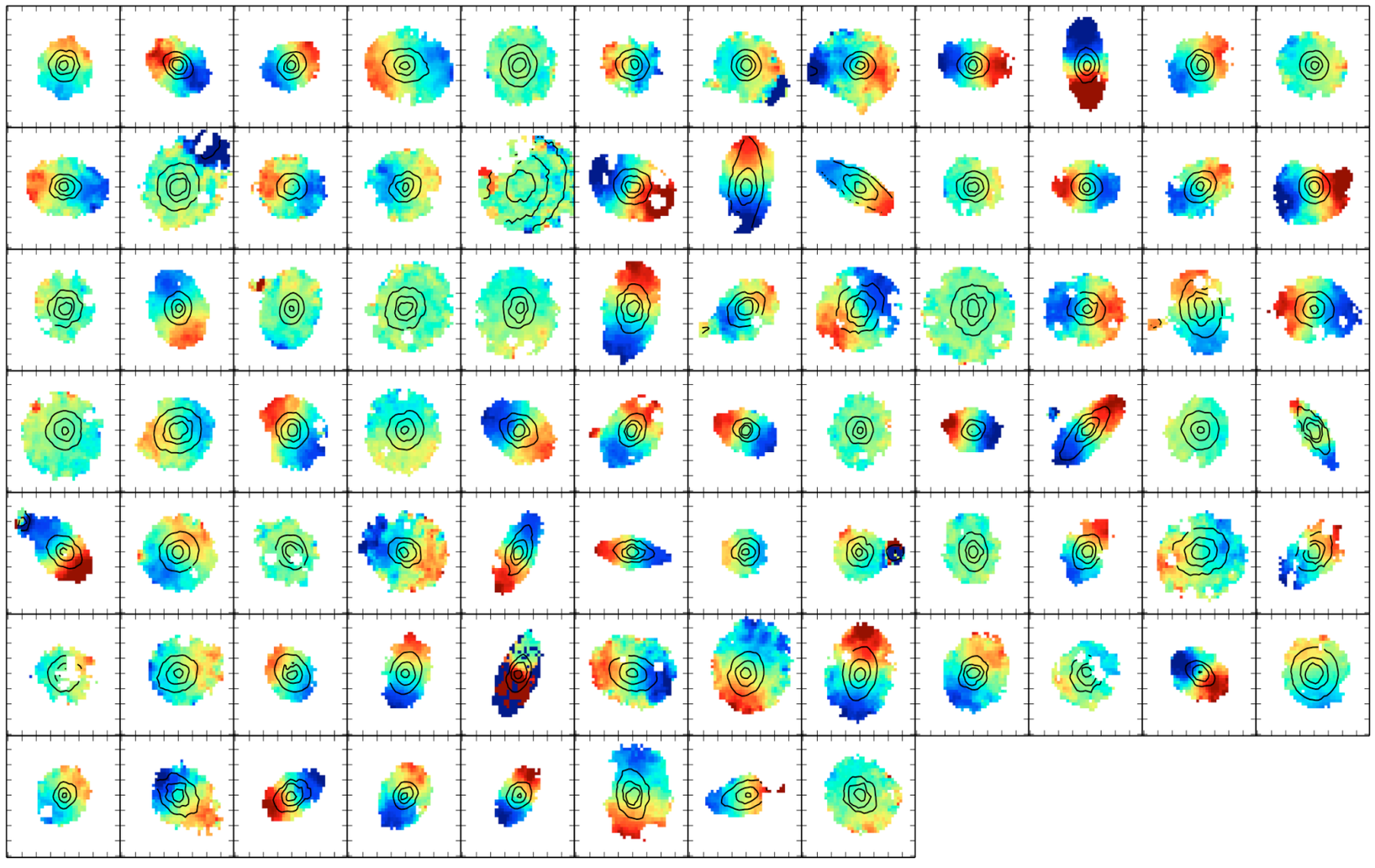
› Specific galaxy cluster fields to be targeted in the South Galactic Cap to probe the highest density environments.

The SAMI survey



Primary sample, high mass secondary sample,
low mass secondary sample

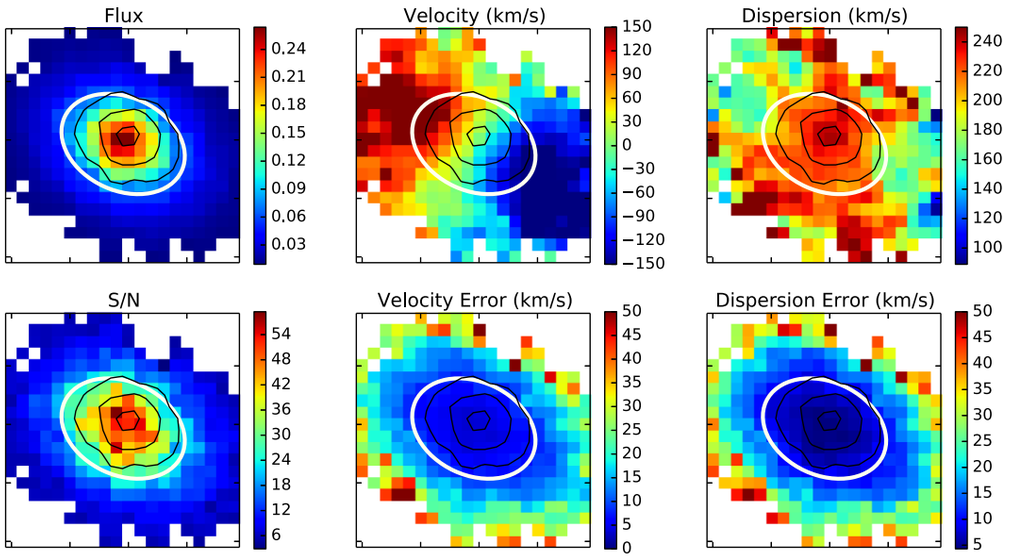
The SAMI survey



First public data release - July 24th

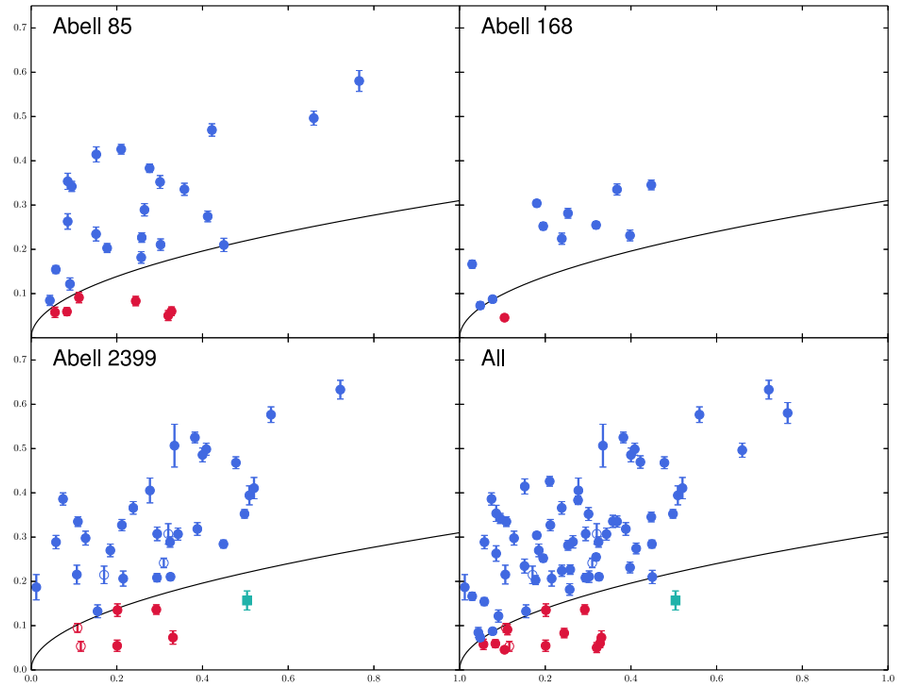
Early SAMI results - Kinematics of Early Type Galaxies

Fogarty et al. 2014



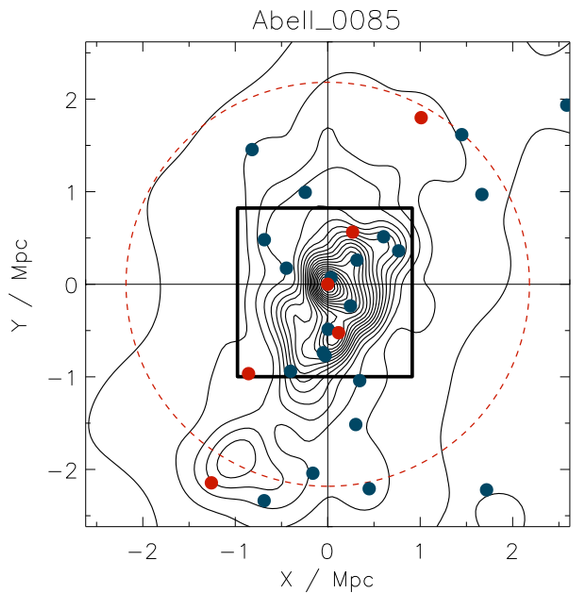
$$\lambda_R \quad \frac{\langle R|V|\rangle}{\langle R\sqrt{V^2+\sigma^2}\rangle}$$

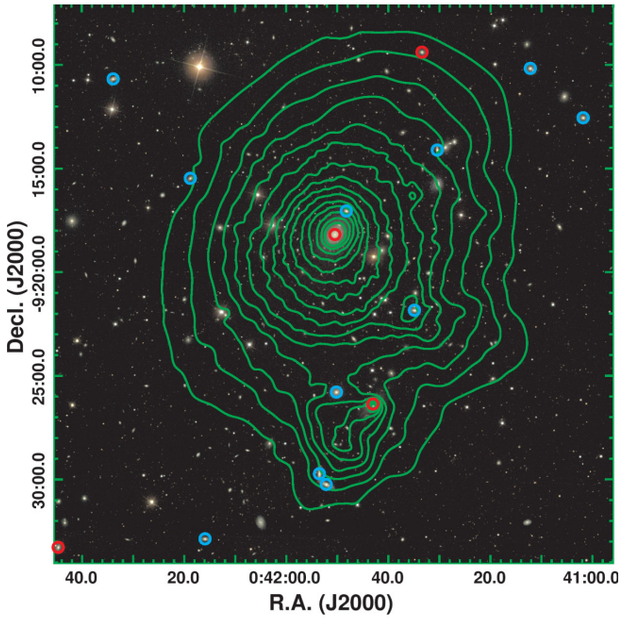
Fast and Slow Rotators



Ellipticity

Is there a kinematic morphology-density relation?

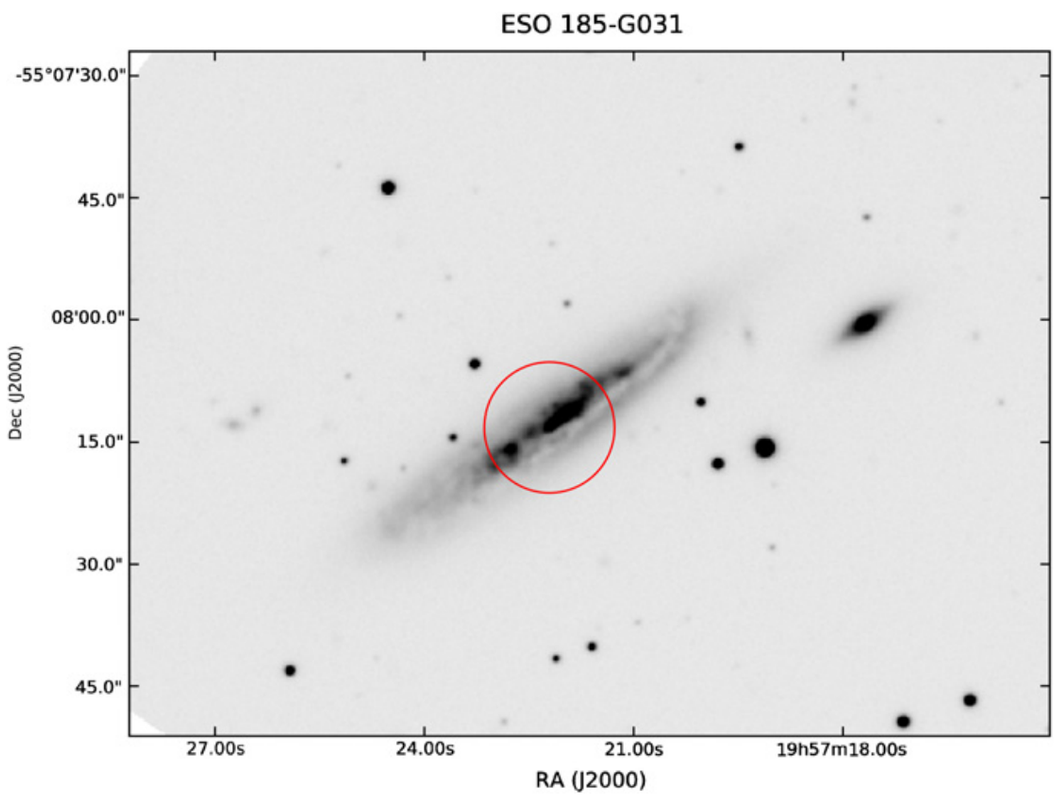


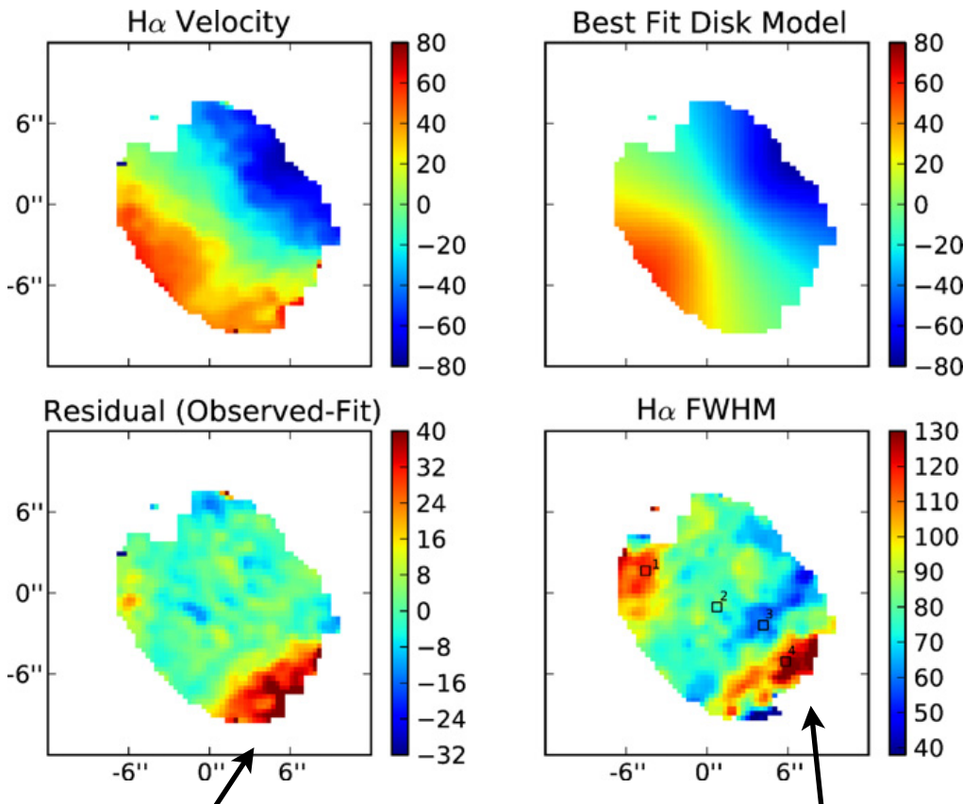


No clear correlation between environment and slow rotators

Early SAMI results - Galactic winds

Fogarty et al. 2012



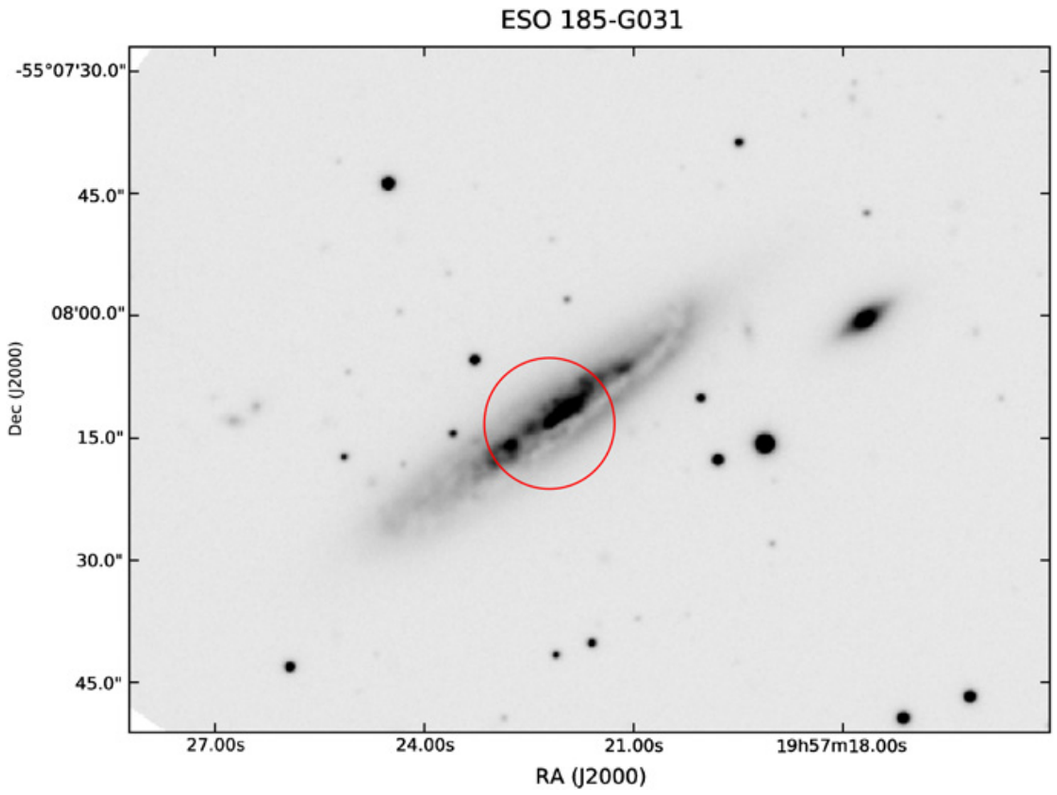


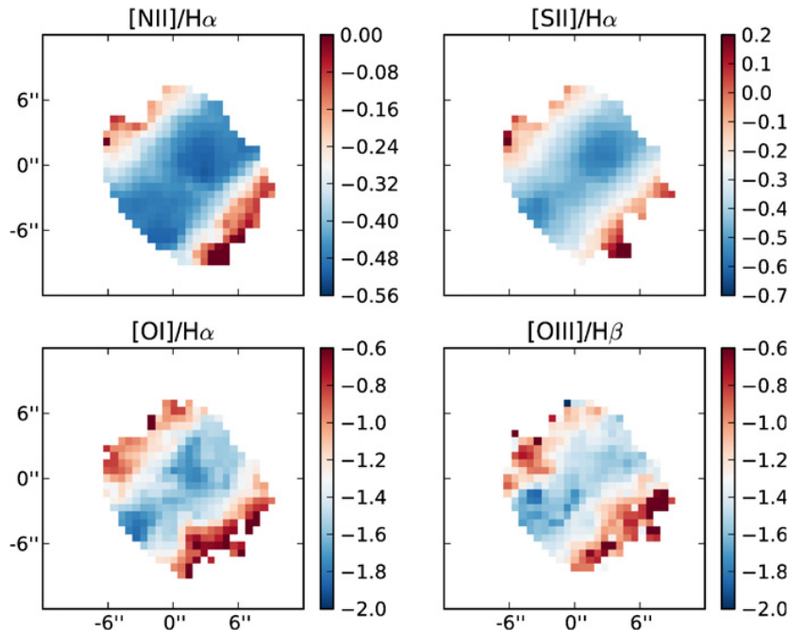
Excess in the residual map

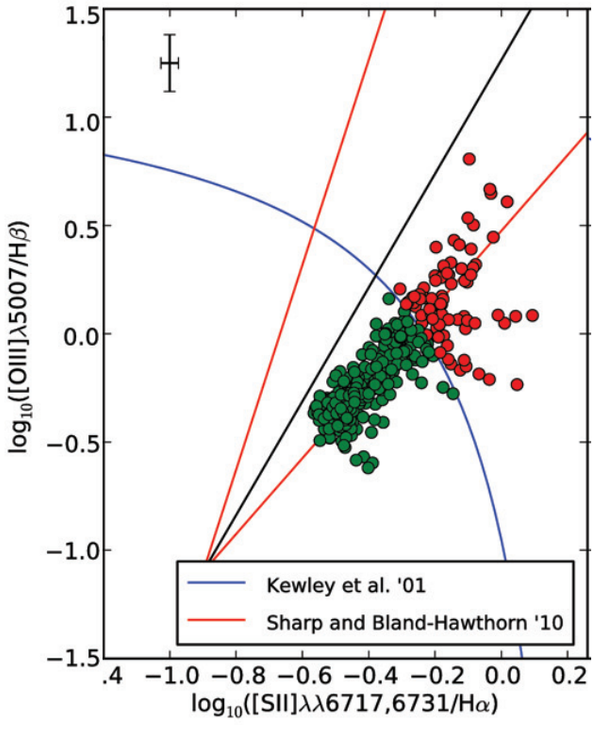
Broad component

Early SAMI results - Galactic winds

Fogarty et al. 2012



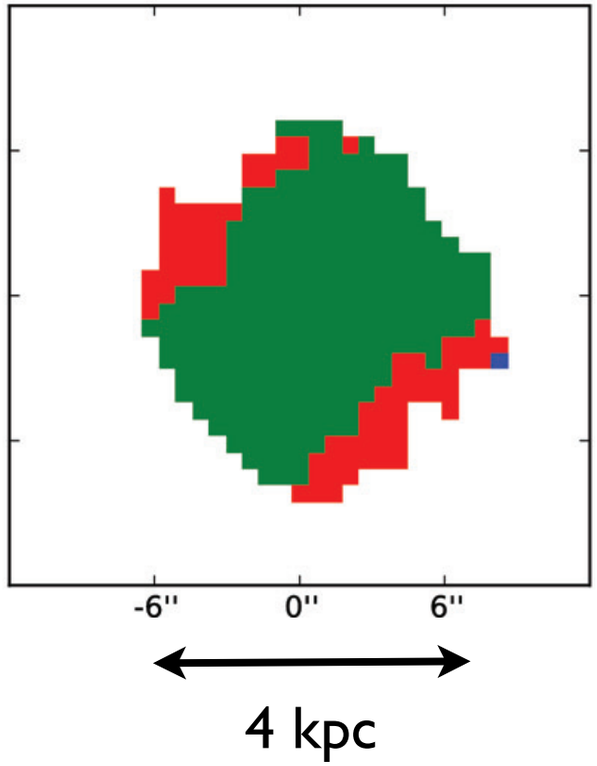




AGN

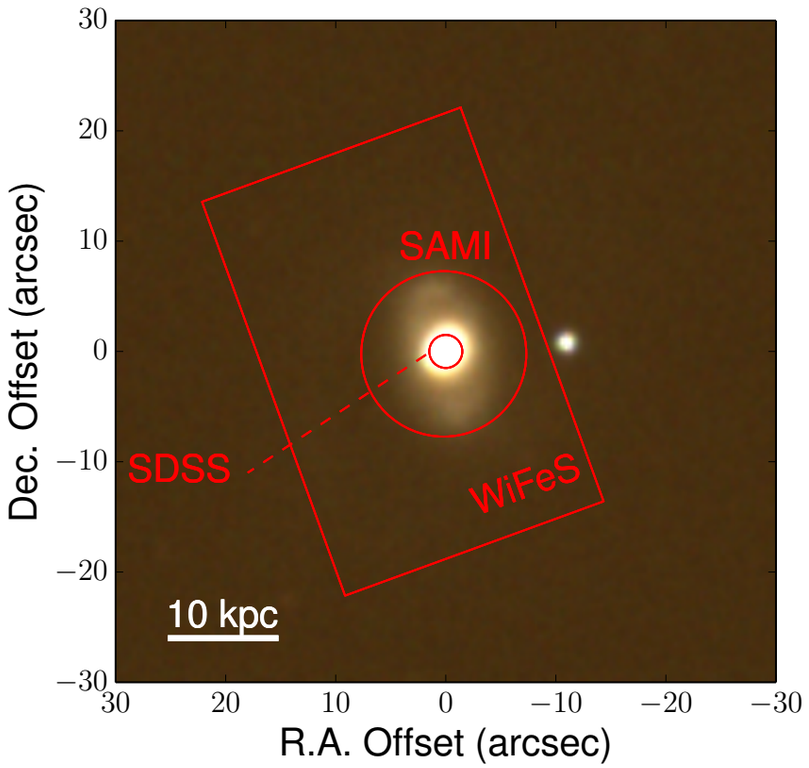
shocked

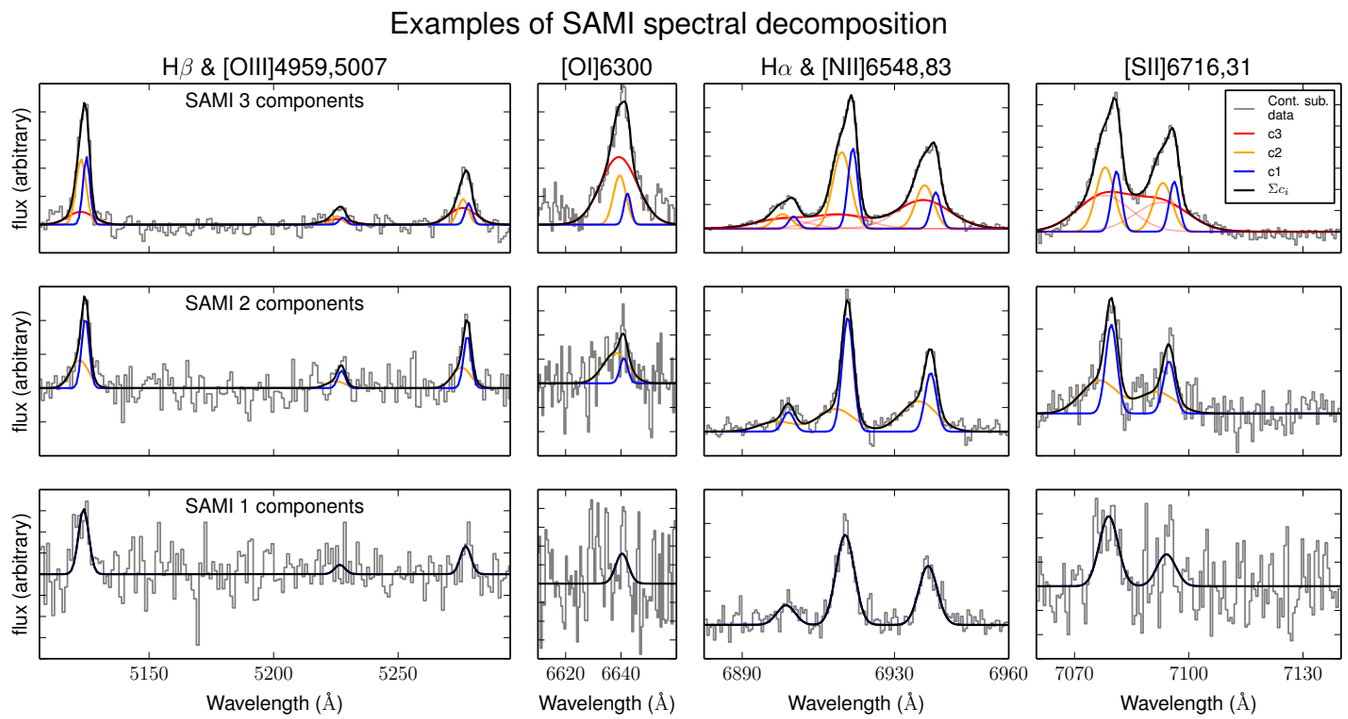
star formation

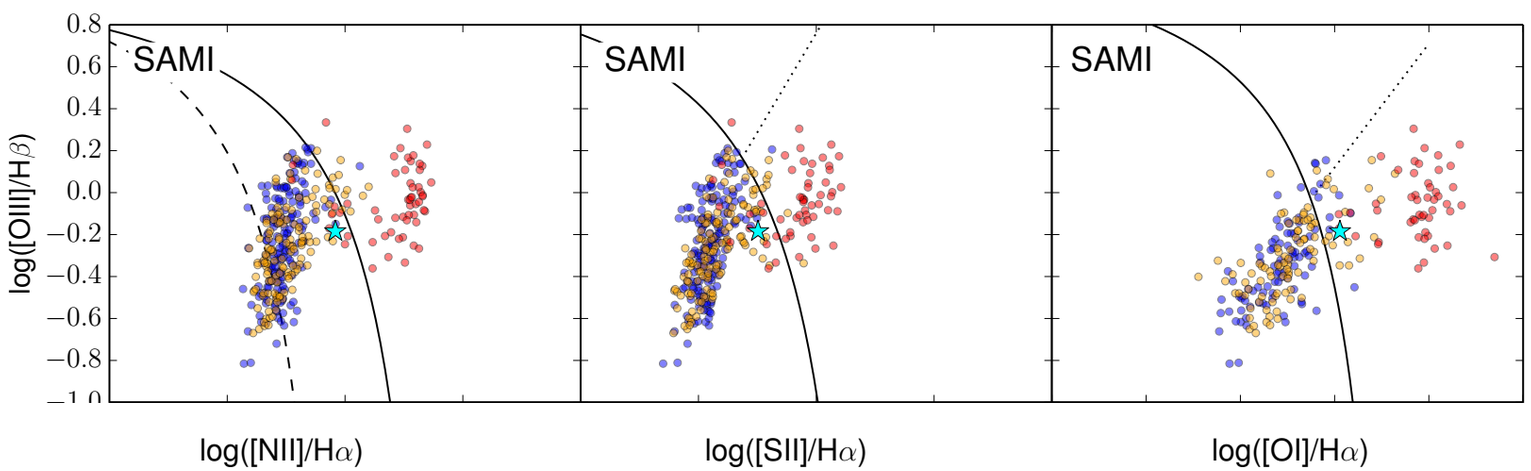


Early SAMI results - Shocks and outflows

Ho et al. 2014







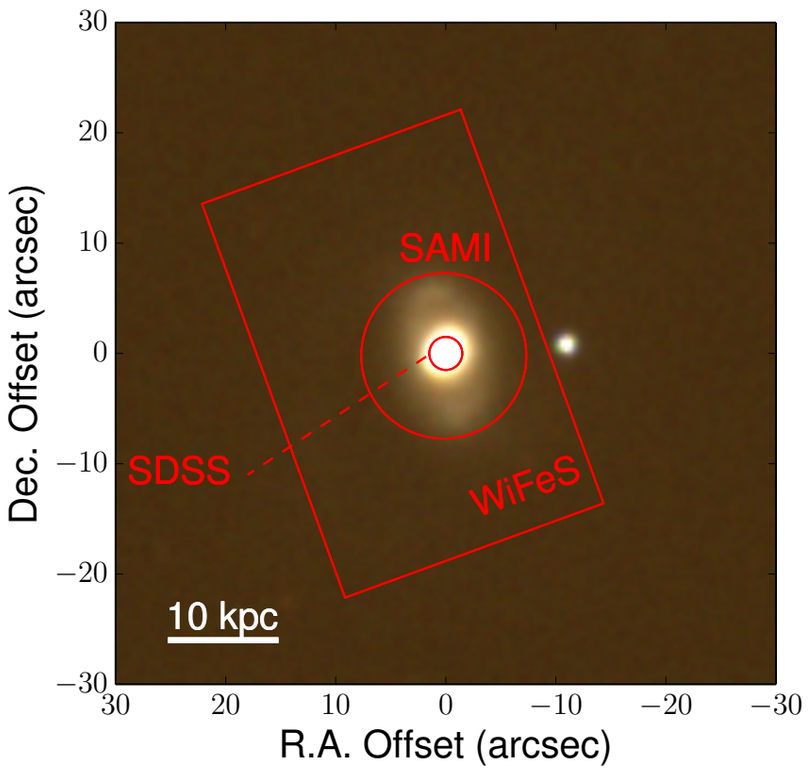
Narrow (C1)

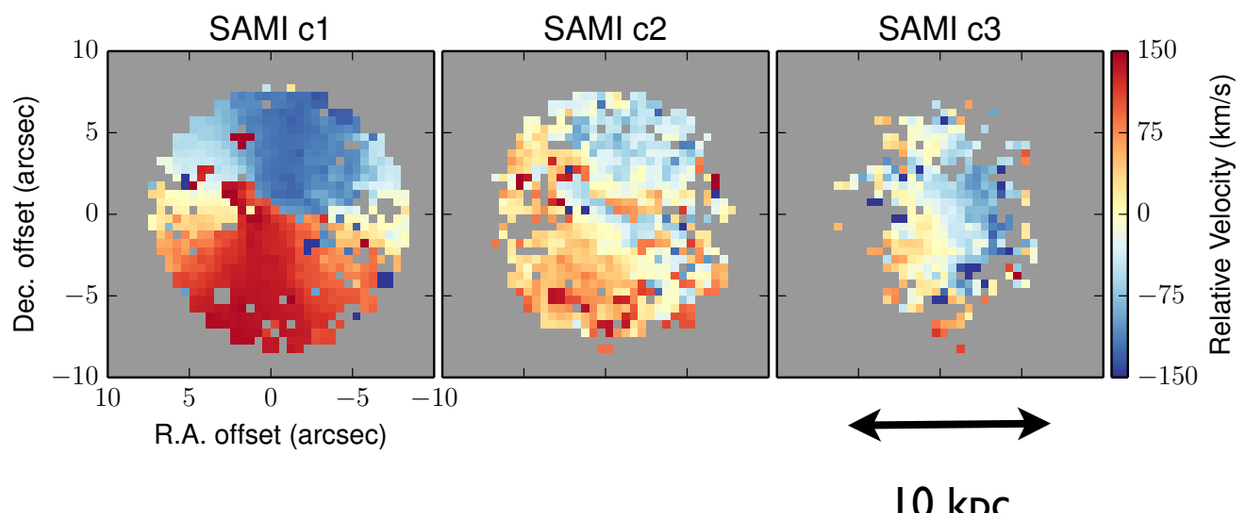
Broad (C3)

Intermediate (C4)

Early SAMI results - Shocks and outflows

Ho et al. 2014





Outflow driven by a starburst

Excitation from UV photons from star formation and shocks

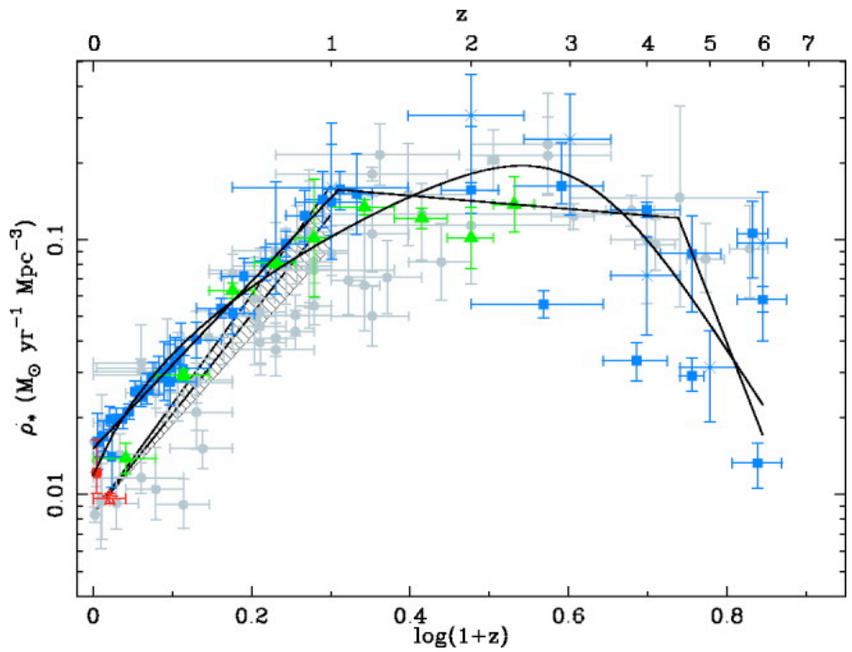
ULTIMATE Science

Everything you had seen in the previous slides but at at z~1

- Gas and stellar kinematics
- Star formation, how it is distributed
- AGN activity and shocks
- Metallicity gradients
- Inflows and outflows

The Universe at z=1

- It is 7.8 billion years younger (middle age)
- It is 8 times denser
- The SFR density is 10 times higher (more SNe)
- The AGN number density is ~100 times higher
- Matter dominates



How do the processes that shape galaxies at z=1 differ from the ones we see today?

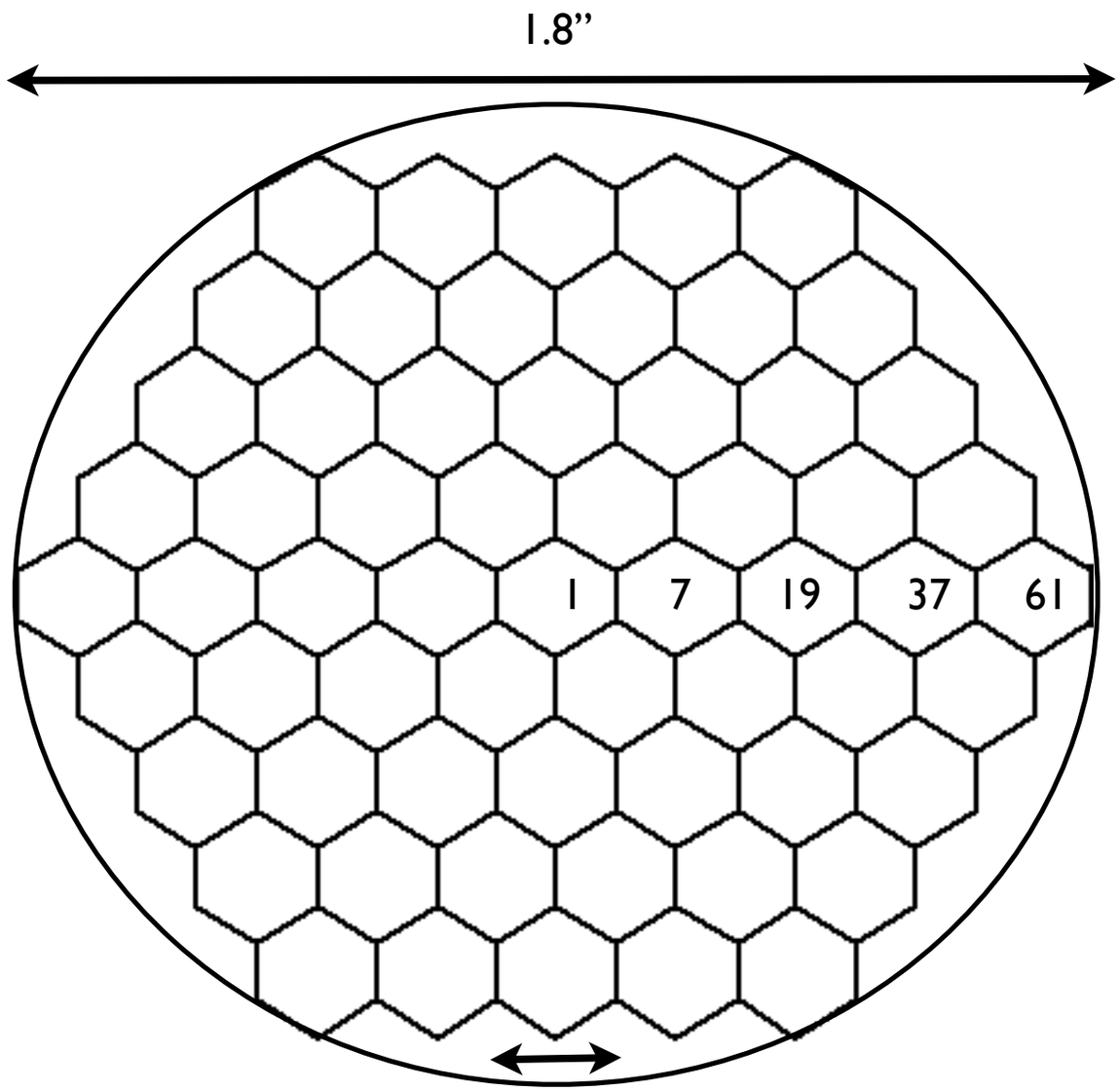
One might expect galactic winds to be far more common

SAMI and ULTIMATE

Characteristic	SAMI @ z~0.05	ULTIMATE @ z~1
Number of IFUs	13	16 (32)
FoV of positioner	3.6 Mpc	6.9 Mpc x 3.9 Mpc
FoV of IFU	15 kpc (15”)	14.6 kpc (1.8”)
Number of fibres per IFU	61	61
Fibre pitch	1.6 kpc (1.6”)	1.6 kpc (0.2”)
Minimum sep.	30kpc (30”)	160 kpc (20”)
Spatial resolution	1.6”	0.2”

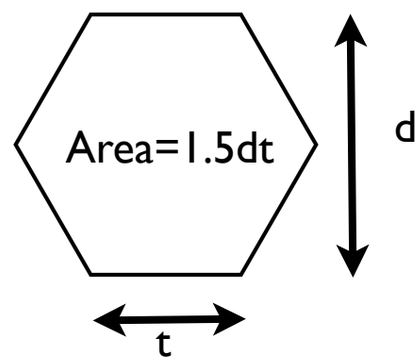
SAMI undersamples the PSF. SAMI dither the telescope to regain the lost resolution

Hexagonal tiling

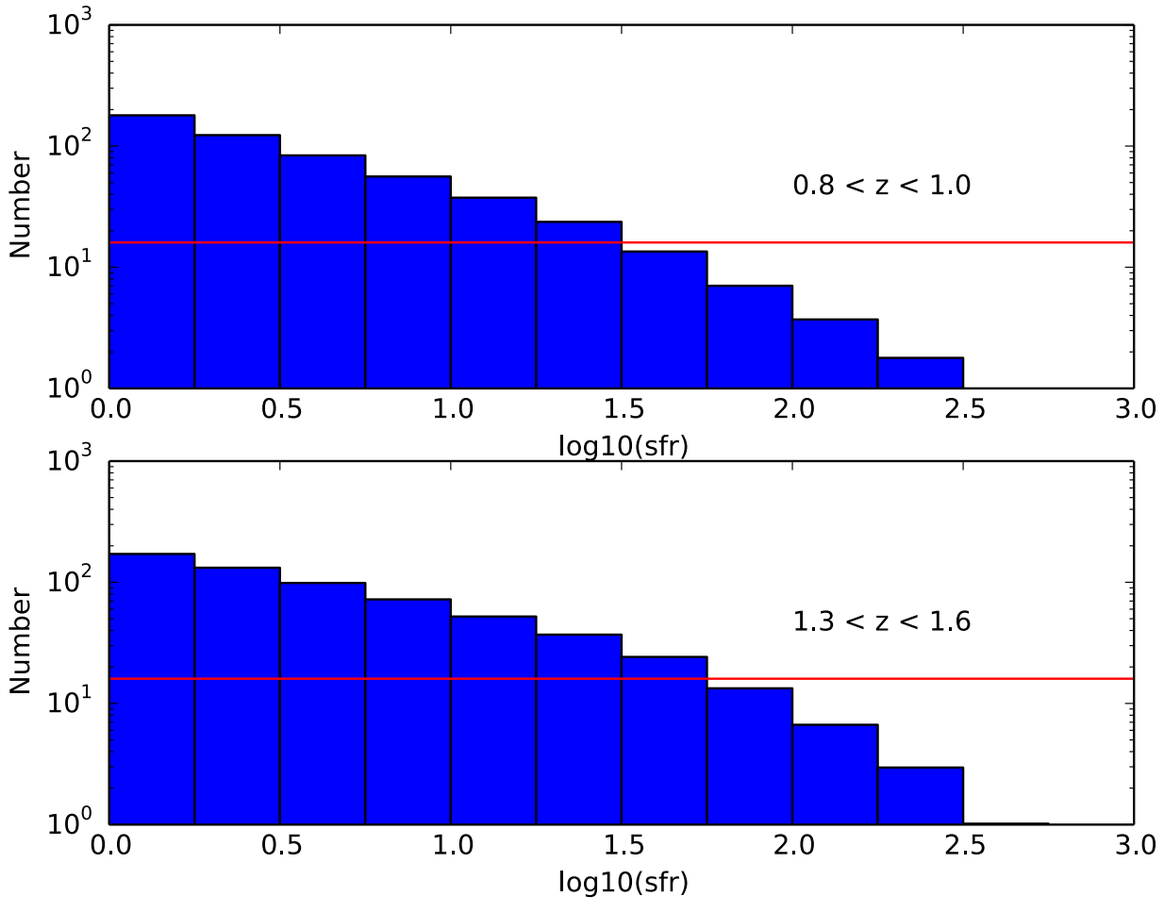


Area= 61 1.5 $d^2 / \sqrt{3}$

Area= 2.11 sq. arc seconds



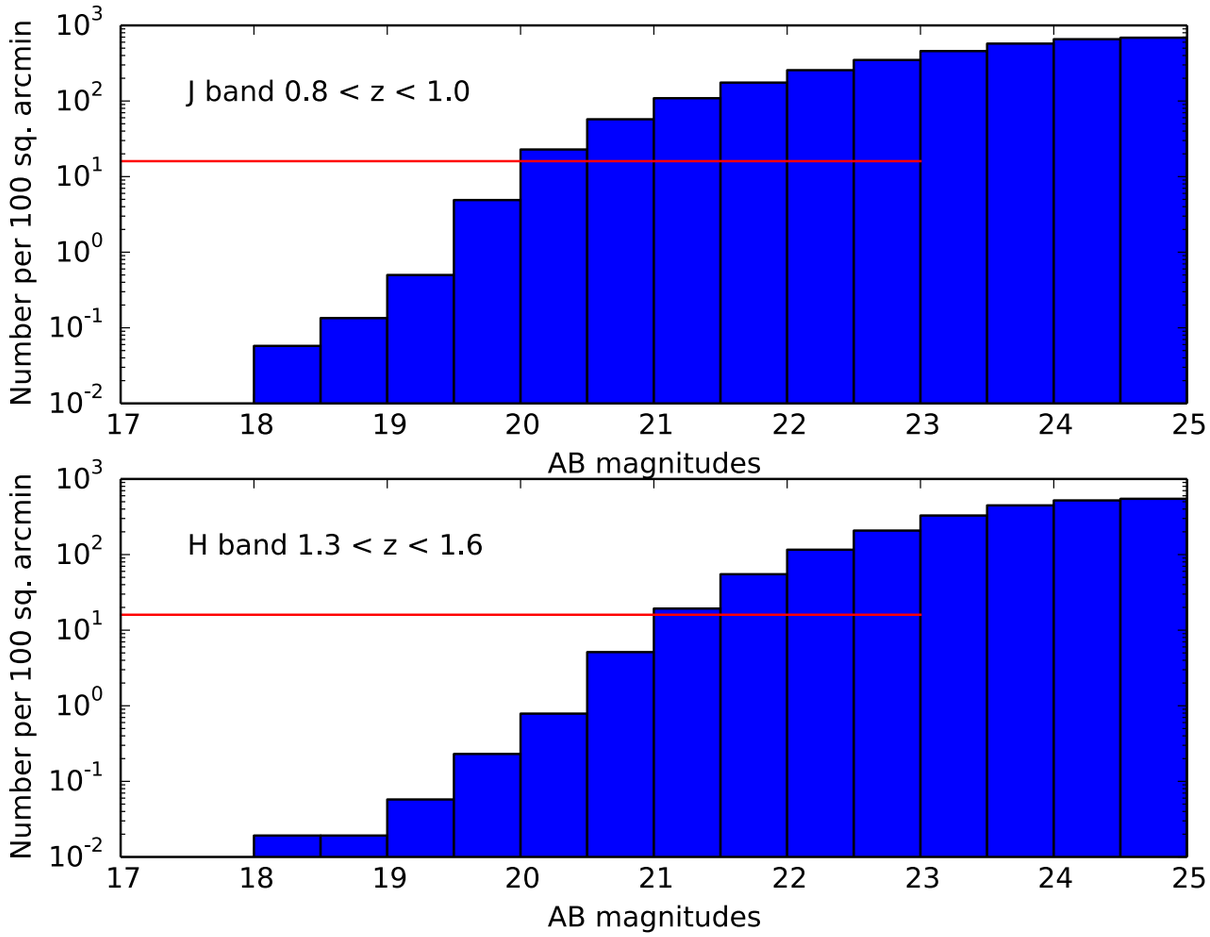
Target density - Emission line galaxies



7,200 seconds

Redshift	Wavelength	Line Luminosity (erg/s/cm Angstrom per square arc second)	S/N KMOS	KMOS efficiency (%)	S/N nuMOIRCS	# IFU elements	S/N per IFU element
0.89	1237	3.14E-16	60	16	40	28	7.6
1.45	1610	9.67E-17	41	24	24	28	4.5

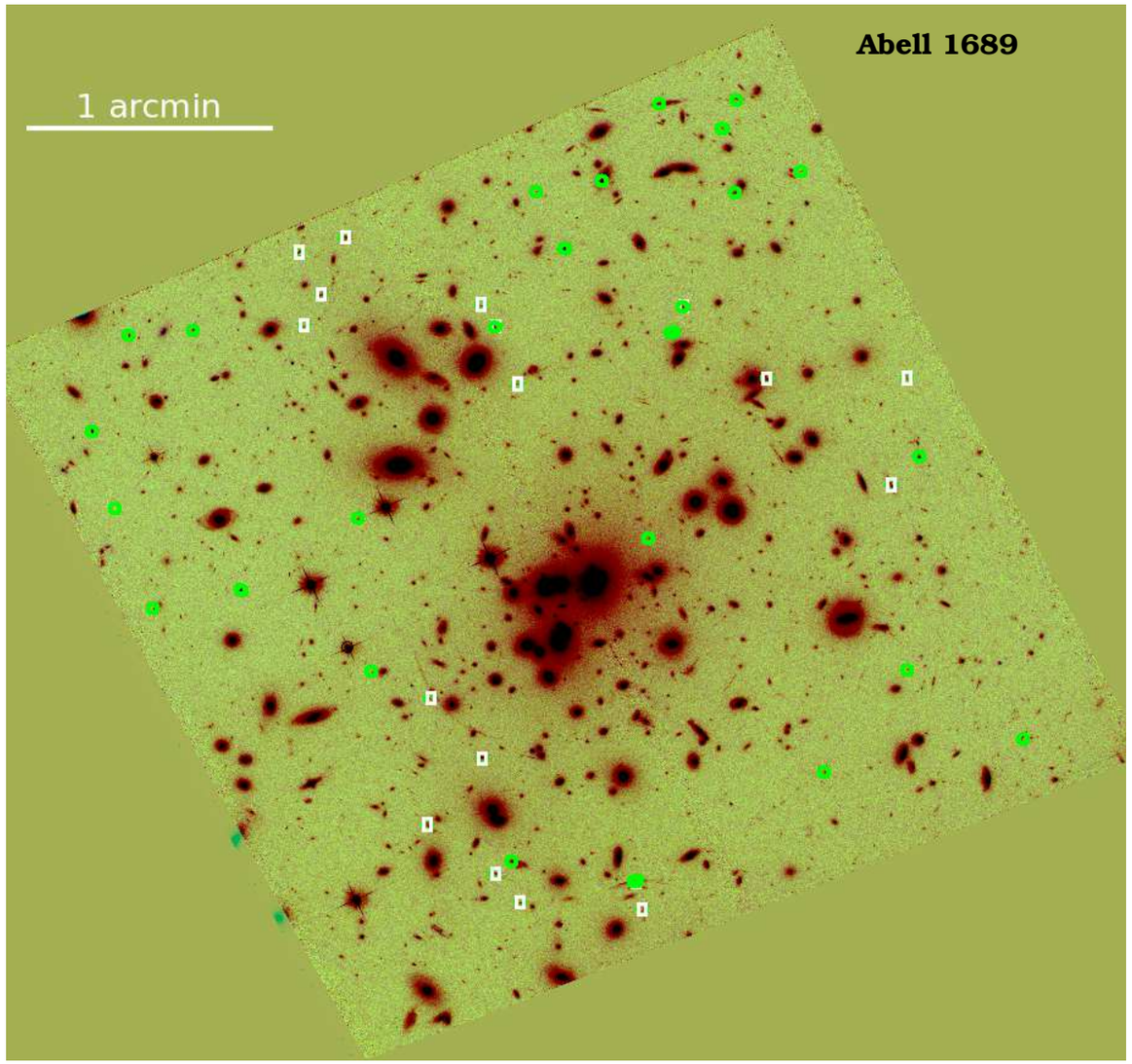
Target density - continuum sources

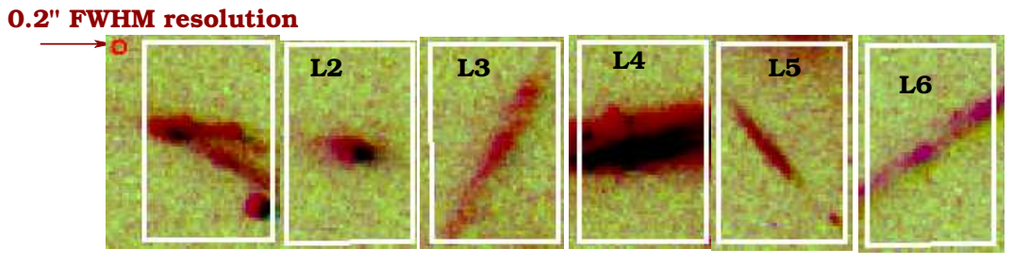


28,800 seconds

Redshift	Mag (AB)	Wavelength	Wavelength Bin	S/N KMOS	S/N nuMOIRCS	# IFU elements	S/N per IFU element
0.89	20.5	1182	1.65	24	16	28	3.0
1.45	21.5	1653	2.03	15	9	28	1.7

Gravitationally lensed galaxies

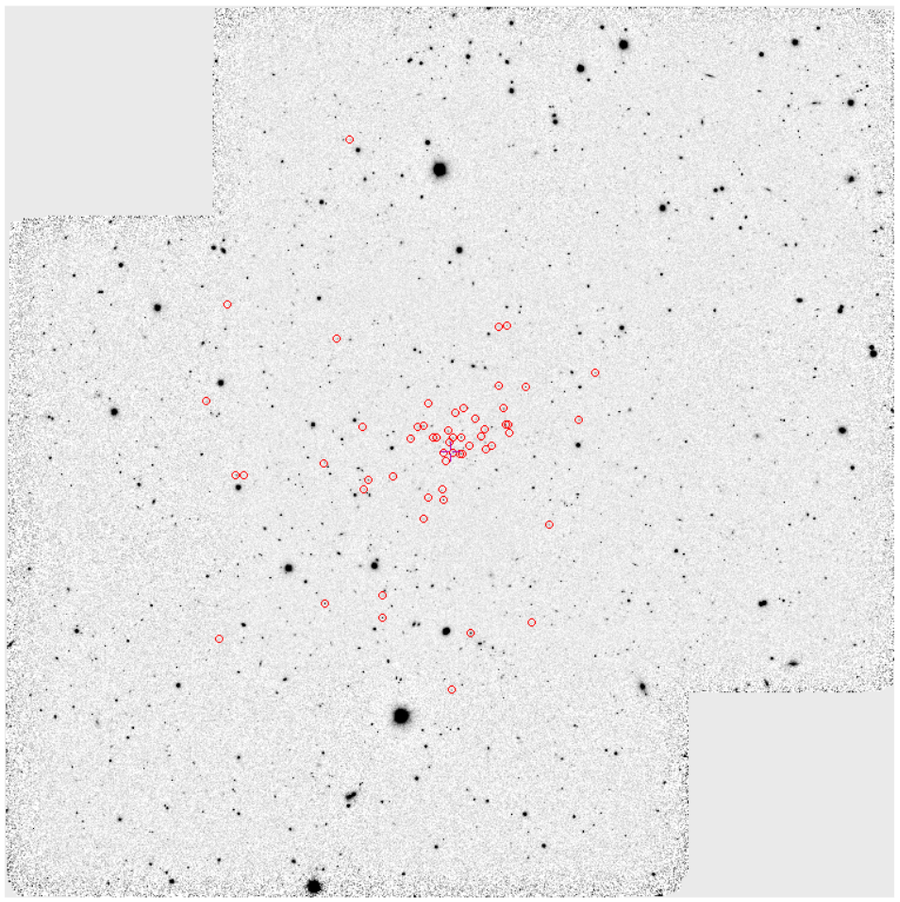




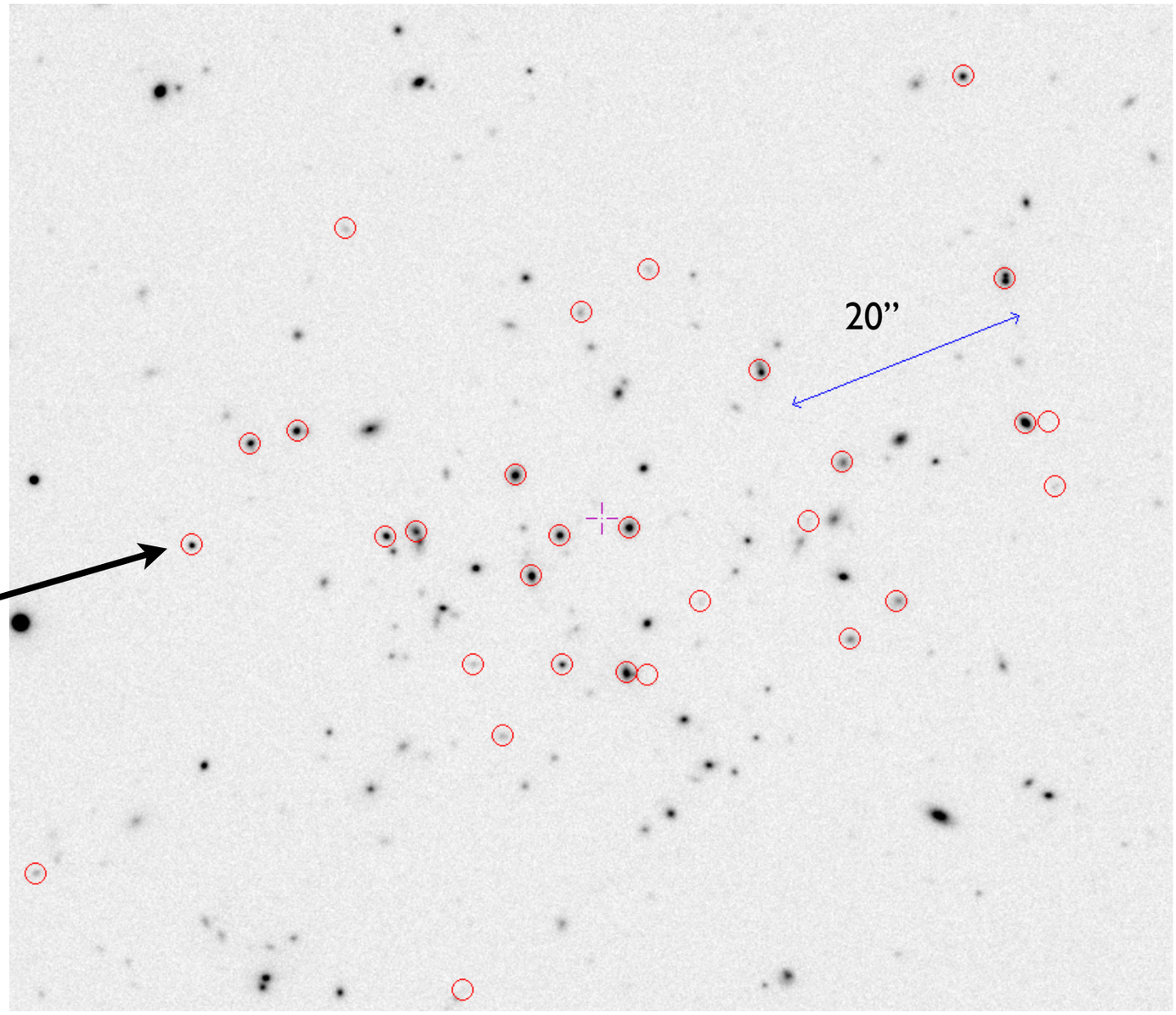
Cluster at high redshift

- Reversal of star formation density relation
- Location of star formation, both in the cluster and in the galaxies themselves
- Mechanism of quenching

XMMSCS 2215 z=1.46



Cluster galaxies



Bonus slides

Sky subtraction with sky fibres