Resolved spectroscopy of cluster galaxies at z~1.4

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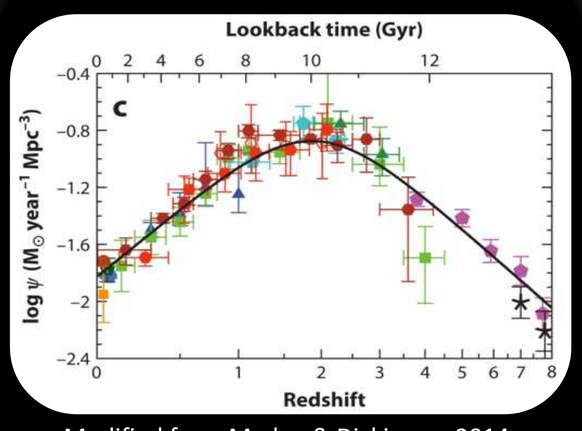
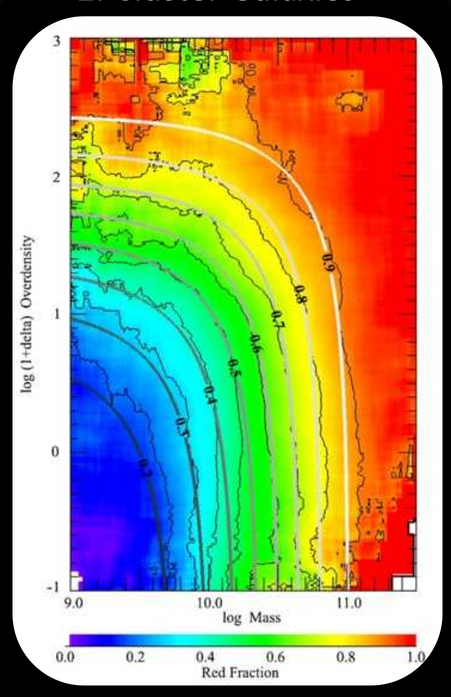
1. Field Galaxies



Modified from Madau & Dickinson, 2014

- Large data volumes across a range of distances. From, for example:
  - KROSS (Stott et al., 2016)
  - KMOS^{3D} (Wisnioski et al., 2019)
- From the plot above we see a clear reduction in star formation rate (SFR) from approximately 10 billion years ago.
- For field galaxies the reasons for this are thought to be 'secular' processes such as star formation feedback.

2. Cluster Galaxies



Modified from Peng et al., 2010

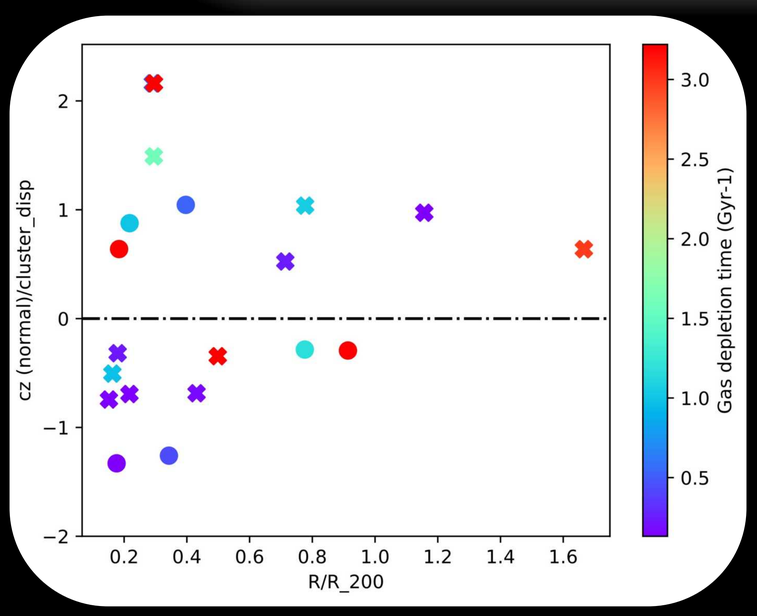
- Much smaller data volumes. From, for example:
  - KCS (Beifiori et al., 2017)
  - K-CLASH (Tiley et al., 2020)
- The processes we see in field galaxies are still important.
- **BUT** we also have to consider the environment these galaxies are in and their interactions with each other (Peng et al., 2010).

5. Discussion/Further work

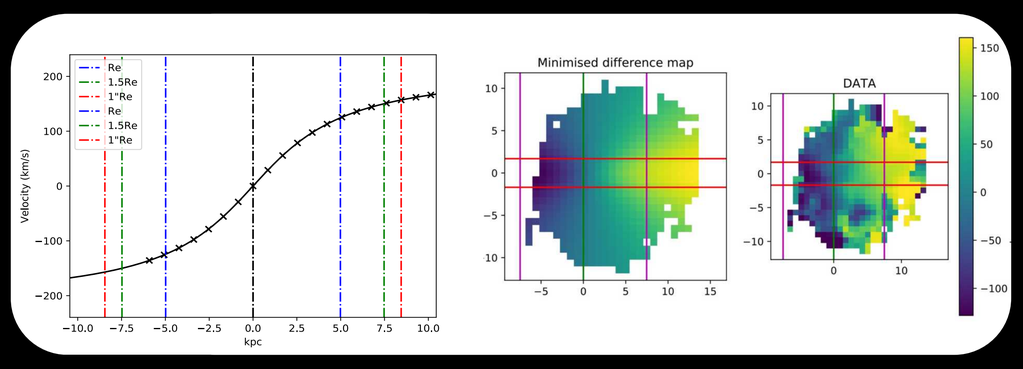
The 3D nature of IFU data to spatially resolve important features allows us to obtain:

- H-Alpha emission maps that can be used to derive star formation rate and velocity data.
- Rotational velocity and velocity dispersion to see how the gas content in the galaxy is moving.
- Dark-matter content.
- Gas depletion times to understand expected quenching timescales.

Future work:
Emission line ratio maps:
- Metal content
- Active galactic nuclei content
- Impact of these on SFR.



← An example 'phase-space' diagram using a velocity analogue corrected for host cluster dispersion. Data from both clusters can now be analysed together, in this example we see show colour graded points for gas-depletion time. The crosses represent the cluster at z~1.46 and the circles for the cluster at z~1.39, from Amos et al., in prep.



Left: 1D galaxy rotation curve. Middle: 2D velocity model map derived from 1D curve. Right: 2D velocity data map. Velocity units are km/s. Data to derive the 1D velocity data was extracted from a region between the two horizontal red lines on the middle and right panels. Plots from Amos et al., in prep.

3. Analysis

To form quantitative comparisons between field and cluster galaxies and their quenching mechanisms we must form models of these galaxies. Two clusters being investigated, XMMXCS J2215.9-1738 (z~1.46) and XMMUJ2235.3-2557 (z~1.39).

- 2D velocity model from 1D rotation model.

Use velocity information to obtain:
- Dark-matter content
- Motions of the galaxies within the cluster.

Emission line ratio maps:
- Metal content
- Active galactic nuclei content
- Impact of these on SFR.

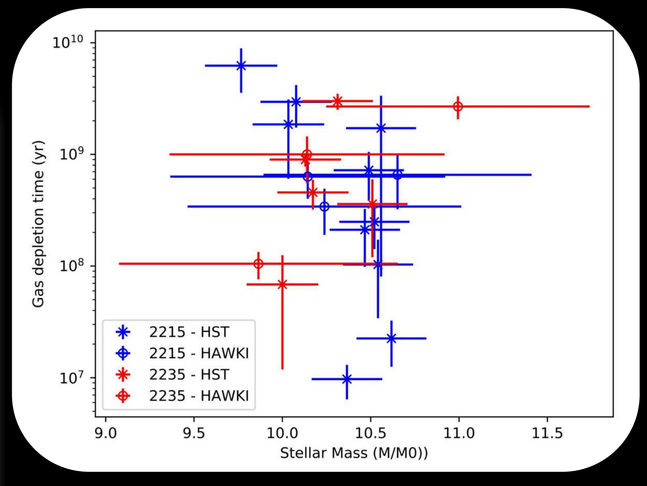
4. Analysis

We need information on the chemical signatures and internal motions of cluster galaxies approximately 10 billion years ago to quantify these quenching mechanisms:

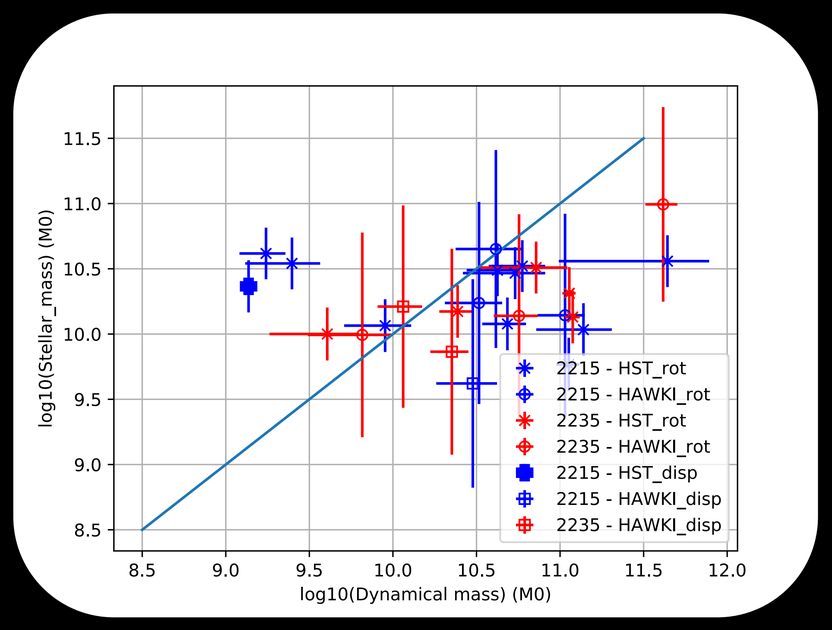
←KMOS data from KCS to gain the 2D information on chemical signatures (e.g. Hα tells us how many stars are being formed). This in turn allows us to study the internal motions and external interactions via velocity mapping.

→Imaging data to assess the shape, size, and mass of the galaxies. This is also essential as it will disentangle the effects we discover in the spectroscopy data.

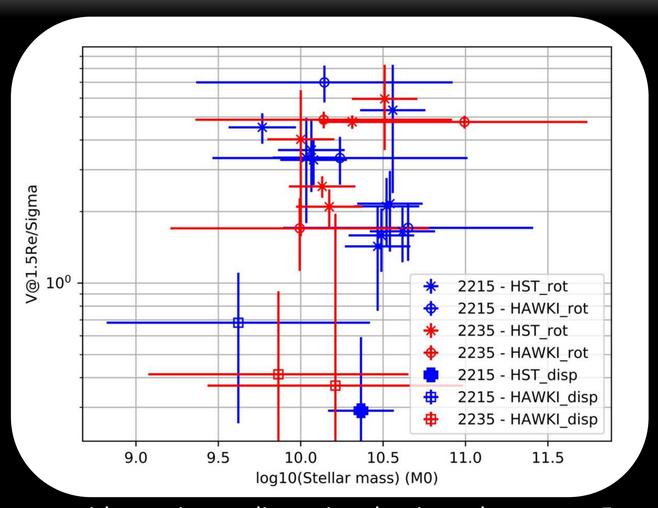
↓ Combining the IFU and imaging data can extract more information from relatively small samples of distant cluster galaxies.



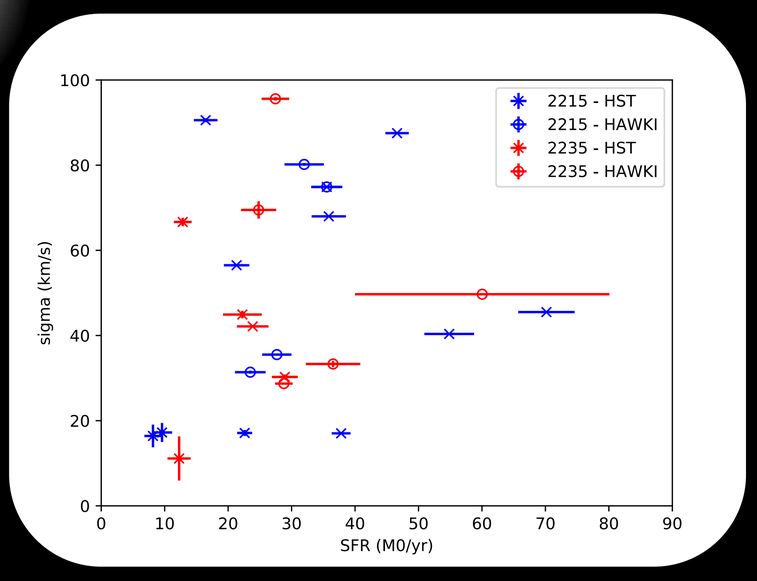
← Gas depletion time with calculated stellar mass, from Amos et al., in prep.



Stellar mass to Dynamical mass, a 1:1 relationship is indicated by the blue line. From Amos et al., in prep.



Stellar mass with rotation to dispersion dominated measure. From Amos et al., in prep.



Sigma vs star formation rate for both clusters. From Amos et al., in prep.

References

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