# Galaxies at z~5: Small, Clustered & Colourful

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## Spectroscopic Survey

Deep spectroscopy was performed over 10 fields using FORS2 at the VLT targeting z~5 galaxies. Candidates were selected using colour criteria applied to deep V, R, I and z-band images.

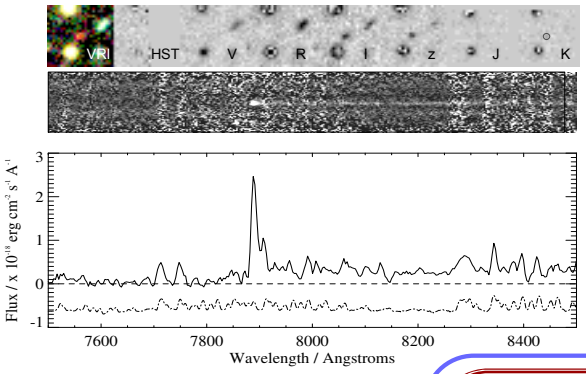


Fig 1: Example of z=5.49 Ly-α line emitter. Top panel - broad-band imaging with a break between the R and I band. Central panel - 2D spectrum. Lower plot - 1D spectrum with a clear Ly-α emission line and break in the continuum.

In the survey, 36 Lyman-α line emitters (LAEs, line fluxes of 5-70x$10^{-18}$ ergs $cm^{-2}$ $s^{-1}$) plus 28 Lyman Break galaxies (LBGs) were confirmed, showing that such galaxies can be identified with only continuum.

## Morphology of z~5 Galaxies

The galaxies were mainly compact, $\langle r_{1/2} \rangle$=0.11" corresponding to 0.7kpc at z=5 (similar to that in Bremer et al. 2004 and Bouwens et al. 2004). However, a quarter of the high redshift galaxies exhibited more complex morphology (Fig 2) with multiple components or internal structure.

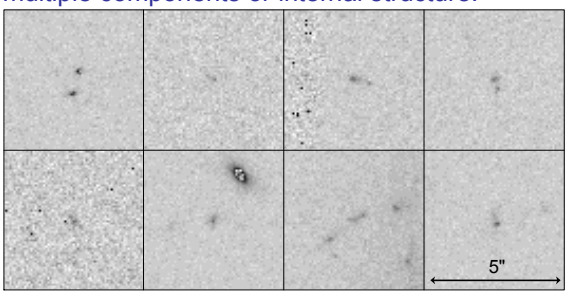


Fig 2: Examples of confirmed high redshift galaxies which are part of a multiple system or with visible internal structure such as multiple peaks or tails of emission.

A higher fraction of complex objects was found within the redshift spikes (~40%). No correlation was seen between the presence of a Ly-α line and complex morphology.

## Conclusions

- **36 Lyman-α line emitting & 28 Lyman Break galaxies confirmed**
- **Majority of galaxies compact**
  - → **$\langle r_{1/2} \rangle$= 0.11" or 0.7kpc**
- **26% galaxies show complex morphology**
- **2 fields have redshift distribution spikes**
  - → **large scale structure**
- **LBGs and weak line emitters have redder UV continuum than strong line emitters**

## Redshift Distribution

Two out of ten survey fields have a redshift distribution showing clear spikes at z=5.1 and z=5.0 suggesting a form of large scale structure is present, but there is no strong spatial clustering across the fields (Fig 3).

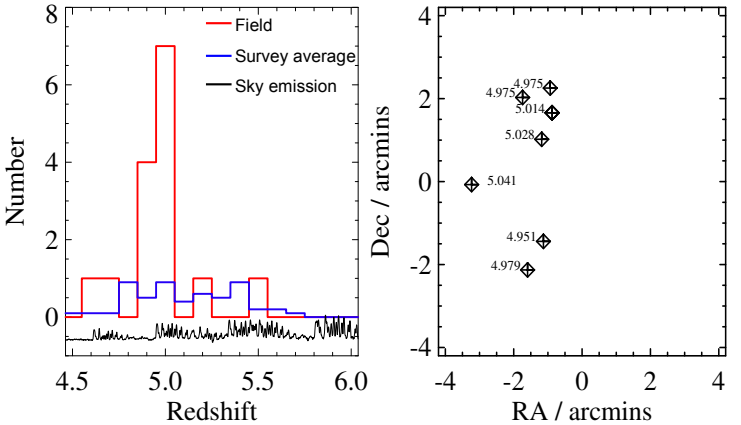


Fig 3: Left - redshift distribution of one field (red), average across 10 fields (blue) and the night sky emission spectrum, a cause of high noise (black). Right - Spatial position of members of redshift spike across survey field show no strong clustering.

For even the closest pairs, the co-moving separation distances are too large to have allowed sufficient interaction for co-eval star formation. Instead, there is more baryonic material in the large scale structure with only a small fraction visible as unobscured UV-bright starburst episodes lasting a few tens of Myrs (assuming the young ages of Verma et al. 2007).

## Rest-frame UV colours

The I-z colour, probing the rest-frame UV continuum, of Lyman-α emitting galaxies was consistently bluer than that of Lyman Break galaxies (Fig 4).

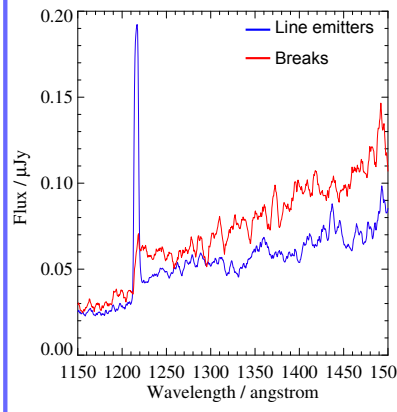


Fig 4: Spectral stack of line emitting (blue) and break galaxies (red) demonstrating a redder slope in LBGs. This was also seen in the individual I-z colour after correcting for redshift and inter-galactic absorption.

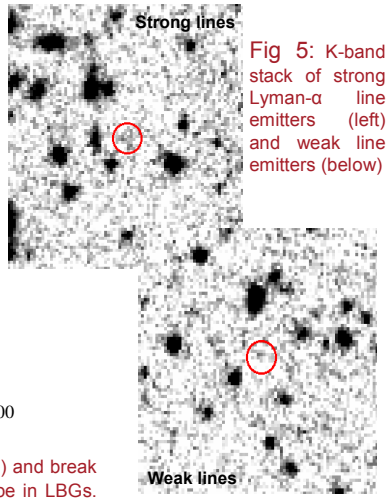


Fig 5: K-band stack of strong Lyman-α line emitters (left) and weak line emitters (below)

Also, stronger LAEs had a bluer I-K colour than weaker line emitters in the stacking of the shallow K-band (Fig 5). These colours suggest that the stellar populations of LAEs are younger than those observed in the LBGs. No dependence on environment was observed.