Environment, Kinematics, & Star Formation History of Infalling Faint [OII] Emitters in z=0.4 Cluster Abell 851 (Cl 0939+4713)

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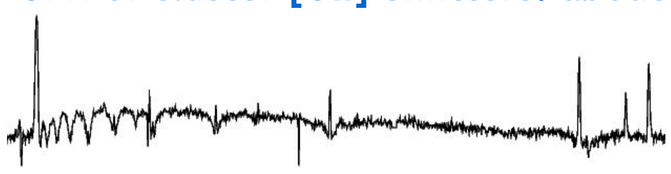
Abell 851 is a rich cluster presenting filamentary structures of galaxies (Kodama et al. 2001) along which the galaxies may be accreted. We selected star-forming cluster galaxies to i ~< 23 and r = 2 Mpc, using narrowband [OII]3727 imaging, and followed up spectroscopically using Keck LRIS & DEIMOS. We find that typical [OII] emitters show spectral signs of dusty starbursts with decay timescales of ~< 1 Gyr. The frequency of bursts appears comparable or higher than field galaxies at z ~ 1. The velocity distribution suggests that many of the [OII] emitters are accreted to the cluster only recently. Their spatial distribution also suggests a high fraction of those to be clustered in the infall group environments. We conclude the starbursts are likely triggered in the cluster infall groups via galaxy-galaxy interactions, which could be enhanced due to the dynamically active state of Abell 851. We also find a hint that giant and dwarf galaxies evolve differentially in the densest environments.

SFH of cluster [OII] emitters: about 55% are e(a) galaxies!

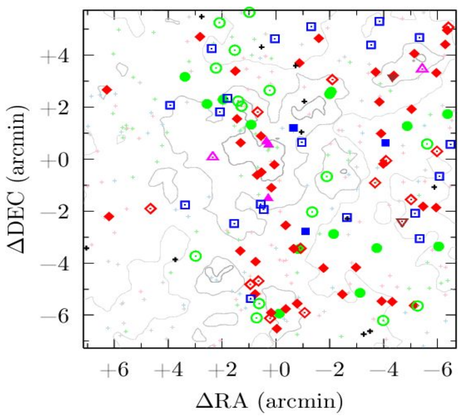


e(a) = dusty starburst

The e(a) spectrum (Poggianti et al. 1999), shown above, is characterized by prominent Balmer absorptions and weak/moderate nebular emission lines. Poggianti et al. (2001) showed this is a signature of **dust-enshrouded starburst**, and our independent modeling with stellar synthesis code (Bruzual & Charlot 2003) and photoionization code Cloudy (Ferland et al. 1998) confirms this interpretation.

Field region is populated by blue, star-forming disk galaxies.

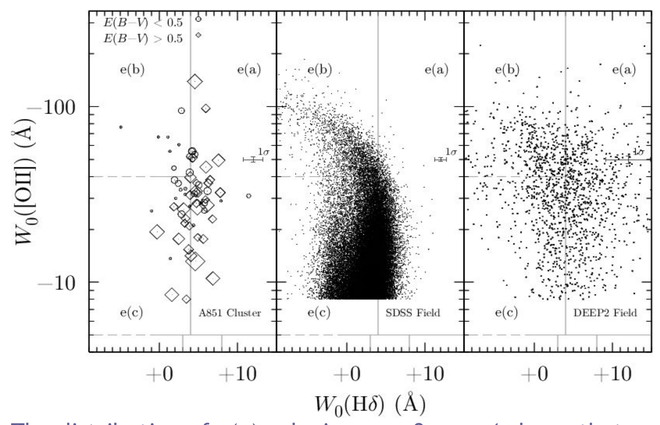
Environments: e(a) in infall groups!



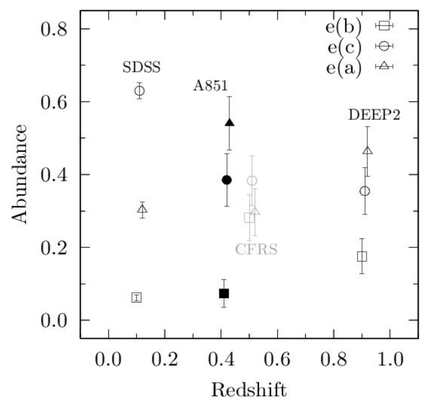
Compared to starburst-dominated (blue) and typical star-forming galaxies (green), the galaxies with e(a) spectra (red) appear clustered preferentially in infall groups, suggesting the galaxy-galaxy interactions in group environment may trigger starbursts.

Infall region is where the actions are!!!

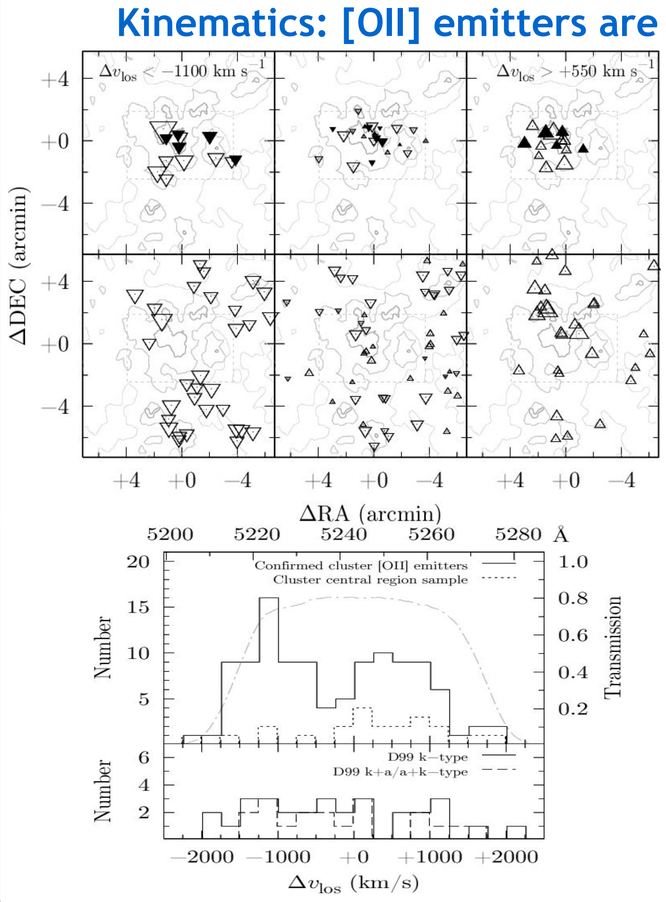
Starburst as active as z=1 universe!



The distribution of e(a) galaxies over 0 < z < 1 shows that Abell 851 hosts as much or more starburst activities as the field galaxy environments at z = 1 from the DEEP2 survey.



Kinematics: [OII] emitters are likely at infall!

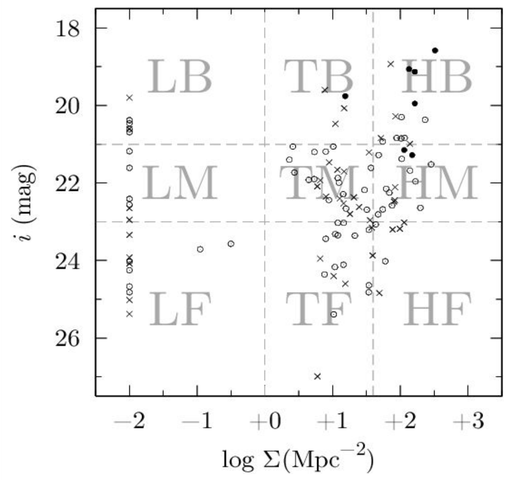


Spatially, many [OII] emitters are found clustered near probable infall groups (top figure, lower panels), and their radial velocities are offset from the cluster systemic redshift. Furthermore, the distribution of the radial velocities for the entire cluster [OII] emitters has a notable deficit at the cluster systemic velocity (bottom figure, top panel). Gill et al. (2005) showed in their simulations that this is a signature of galaxies at the infall phase. Although limited in the sample size, the comparison to non-emission-line galaxies in Abell 851 (Dressler et al. 1999) shows some evidence for kinematic segregation of star-forming galaxies from old, dead galaxies which populate the cluster central region (top panels in the top figure & lower panels in the bottom figure).

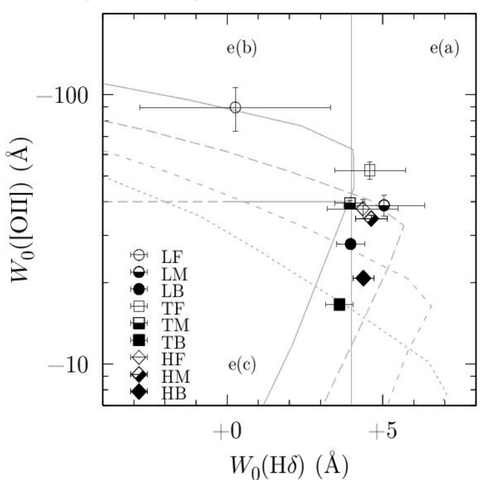
Starburst vs. strangulation

Although starbursts appear to be more frequent in clusters in general, it is not the only mode of cluster galaxy evolution. Strangulation (also termed starvation or suffocation), meaning gradual gas removal, gives rise to so-called “passive spirals,” which is a population morphologically classified into disk galaxies yet lacks ongoing star-forming activities; see Moran et al. (2006) for an example.

Giants vs. dwarfs: Differential evolution?



In the densest environments (in terms of projected galaxy number densities), bright & faint [OII] emitters show interesting differences. Faint [OII] emitters are scarce (HF in the left figure), while the bright ones are abundant (HB) and even show the spectral sign of potential AGN activities (filled circles). The star formation histories derived from the coadded spectra show an interesting trend (figure below).

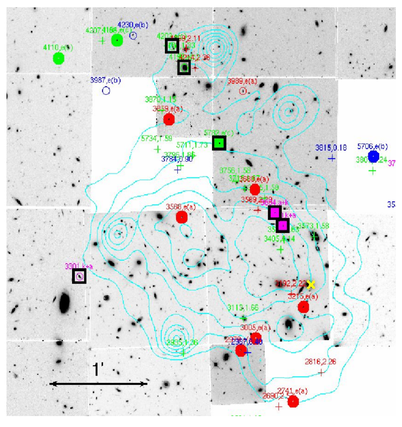


Most subpopulations are consistent with e(a) galaxies. Faint [OII] emitters tend to show stronger [OII] emission, and the ones in the low-density environments show a starburst-dominated spectrum.

The lack of faint [OII] emitters in the dense environment shows such environments to be effective in suppressing star formation, as in tidal destruction (galaxy harassment) or stripping of gas supply.

Cluster central region is populated by red, dead bulge-dominated galaxies.

Abell 851: A highly active cluster!



As seen left in the X-ray emission contour (cyan) from De Filippis et al. (2003), Abell 851 is dynamically young. The previous studies indicate that dynamically active clusters may host a higher fractions of star-forming galaxies/AGNs. The notably high starburst fraction in Abell 851 might be the result of cluster dynamical assembly, in which the frequency of interactions among infall structures could be enhanced.

For details:

Sato & Martin 2006, ApJ, 647, 934
Sato & Martin 2006, ApJ, 647, 946