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Presentation Requested: poster
Category: Environment, Large Scale Structure and Galaxy Evolution
Question: Other

Anti-hierarchical galaxy evolution at $z \leq 1$

A pencil beam pilot survey at $0.3 \leq z \leq 1$ of 600 galaxies, reasonably complete up to $R = 23$, was obtained in the course of observations of the ICL of a cluster with the VLT (Giraud et al 2011, 2012) Stellar mixing and synthetic spectra were derived by fitting galaxy SEDs using the *starlight* code. The main features of galaxy evolution visible in our survey are listed below:

1. Absorption-line galaxies do not show significant variation in their continuum energy distributions up to $z = 0.6$ and a moderate decrease of the 4000 Å break amplitude of 6% at $z \sim 0.82$, and 15% at $z \sim 1$. Galaxies at $z \geq 0.8$ still had some star formation about 1 Gyr earlier.

2. Archeological downsizing. The faint absorption-line galaxies at $z = 0.3$ have indexes similar to those of bright absorption-line systems at $z = 0.8$. Our population synthesis models indicate that 50% of the stars contributing to the spectra of faint absorption-line galaxies at z = 0.3 were formed at $z < 1$. This is consistent with cases of truncated red sequences observed in some high-z clusters. This also suggests that the red sequence is still in a building phase at $z \leq 1$.

3. We did not find cases of small ellipticals without some relic of intermediate age star formation.

4. The average spectra of galaxies with emission lines show significant systematic variations in their energy distribution with z, consistent with what is observed in other regions of the Universe, namely:

   (a) the brightest red emission-line galaxies at $z < 0.5$ have the oldest stellar populations;

   (b) the Universe at $z \leq 0.65$ is repopulated with starburst galaxies at a constant rate down to $z \simeq 0.3$ while at $z \geq 0.65$ the birthrate of starbursts, or the AGN fraction, is higher;

   (c) red emission-line galaxies become redder with decreasing redshift and have lower EQW([OII]) and higher D(4000).

5. Downsizing of starbursts. The intrinsic luminosities of starbursts decline with cosmological time. Downsizing must take place both in luminosity and in number density. In our sample the "down-sizing" phenomenon is of $1.2 - 1.7$ magnitudes from $z = 0.4$ to $z = 0.9$

6. The red limit in the energy distribution of emission-line galaxies at $z \leq 0.6$ is typical of bulge-dominated spiral galaxies with moderate star formation, and of early-type LINERs.

   To summarize we have observed a combination of four effects, of which the following three are shifting from bright to faint systems with decreasing z : strong star formation in emission-line galaxies; aging in emission-line galaxies; and aging in absorption systems. The fourth effect is the re-population of starbursts in each redshift bin.

   Cold Dark Matter (CDM) models are hierarchical in the sense that large halos are built from the merging of small halos. Our observations indicate that in our pencil beam sample of the Universe star formation and halo assemblage are not in phase. This would imply that the era

when CDM merging and star formation might have been in phase was much further in the past. Relics of building blocks which could have been left aside in the form of small ellipticals with very old end of star formation are not found in our sample.