COMPACT GALAXIES AT Z = 0.2–1.3: IMPLICATIONS FOR GALAXY EVOLUTION AND THE STAR FORMATION HISTORY OF THE UNIVERSE

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Abstract. We study the global properties of 51 compact field galaxies with redshifts $z \sim 0.2 - 1.3$ and apparent magnitudes $I_{814} < 23.74$ in the flanking fields of the Hubble Deep Field. All these galaxies have angular half-light radii $r_e < 0.5$ arcsec. Keck spectra covering ~4000–9000 Å, combined with HST I_{814} images and Keck V-band images, were used to derive redshifts, $V_{606} - I_{814}$ colors, absolute blue magnitudes (M_B), linear half-light radii (R_e), blue average surface brightnesses within R_e (SB_e), velocity widths (σ), virial masses (M), mass-to-light ratios (M/L), excitations ($O[III]/H\beta$), and star formation rates (SFR). The results of this study can be summarized as follows:

(i): Only 12% of the 51 compact galaxies have absorption-line dominated spectra, while 88% show strong, narrow emission lines, similar to the so-called CNELGs (e.g., Koo, this volume).

(ii): Despite being very luminous (i.e., $L_B \sim L^\star$; see figure 1a), compact emission-line galaxies are low-mass stellar sytems (i.e., $M \leq 10^{10}$ $M_\odot$, typically; see figure 1b).

(iii): Roughly 60% of the compact emission-line galaxies have colors, sizes, surface brightnesses, luminosities, velocity widths, excitations, star formation rates, and mass-to-light ratios characteristic of young, star-forming HII galaxies (see figures 1 and 2). The remaining 40% form a more heterogeneous class of evolved starbursts, similar to local disk starburst galaxies.

(iv): Without additional star formation, galaxy evolution models predict that HII-like distant compacts will fade to resemble today's spheroidal galaxies such as NGC 205 (Koo, this volume).

(v): Our sample implies a *lower limit* for the global comoving SFR density of ~0.004 $M_\odot$ yr^{-1} Mpc^{-3} at $z = 0.55$, and ~0.008 $M_\odot$ yr^{-1} Mpc^{-3} at $z = 0.85$. These values, when compared to a *similar* sample of local galaxies, support a history of the universe in which the SFR density declines by a factor ~10 from $z = 1$ to today (see figure 3). From the comparison with the SFR densities derived from previous data sets, we conclude that compact emission-line galaxies, though only ~20% of the general field population, may contribute as much as ~45% to the global SFR of the universe at $0.4 < z < 1$.

A full description of these results can be found in Phillips et al. (1997) and Guzmán et al. (1997).

Acknowledgements. This project is a collaborative effort of the DEEP team at UC Santa Cruz (http://www.ucolick.org/~deep/home.html). R. Guzmán would like to thank the scientific committee for their kind invitation to participate in this Joint Discussion. Funding for this project is credited to NASA grants AR-06337.08-94A, AR-06337.21-94A, GO-05994.01-94A, AR-5801.01-94A, and AR-6402.01-95A from the Space Telescope Institute, and NSF grants AST 91-20005 and AST 95-29098.

References

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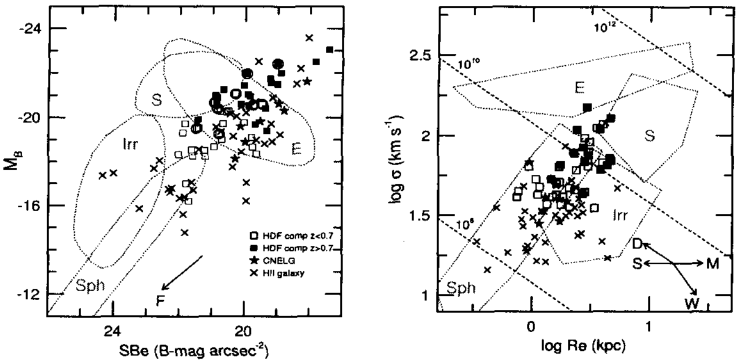

Figure 1. (a): SB_e vs. M_B. Open squares: compacts at $z < 0.7$; filled squares: compacts at $z > 0.7$; circles: absorption-line compacts; crosses: nearby HII galaxies; dotted lines indicate the locus occupied by various other types of local galaxies; the arrow (F) represents the direction of fading. (b): R_e vs. σ. Symbols as before; dashed lines represent constant mass-lines in $M_\odot$; the arrows represent the effects of dissipation (D), mergers (M), stripping (S) and winds (W) on R_e and σ. We adopt $H_0 = 50$ km s^{-1} Mpc^{-1} and $q_0 = 0.5$.

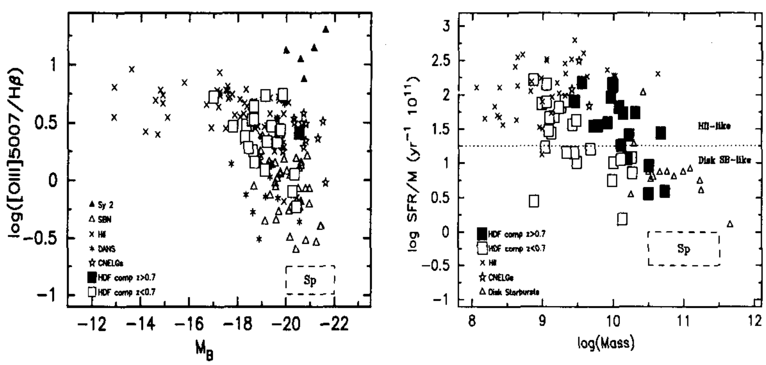

Figure 2. (a): M_B vs. $[OIII]/H\beta$. Local galaxies: DANS=Dwarf Amorphous Nuclear Starbursts; SBN=Starburst Nuclei; Sy2:=Seyfert 2 galaxies; HII=HII galaxies. Dashed lines represent the approximate location of spiral galaxies. (b): M vs. SFR/M. Symbols as before; the dotted line represents the division between HII-like and disk starburst-like galaxies adopted in our classification.

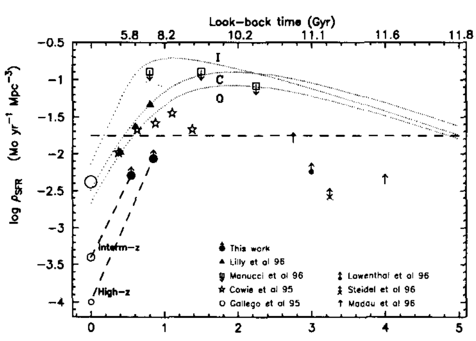

Figure 3. SFR density vs. redshift. The two large filled circles are the estimates for compact galaxies at $z < 0.7$ and $z > 0.7$, respectively. These values should be compared to the open circles labelled "Interm-z" and "High-z, which represent the values for *similar* samples of nearby compact galaxies. Dotted lines represent Pei & Fall's models (1995). The dashed line represents the fiducial value. We adopt $H_0 = 50$ km s^{-1} Mpc^{-1} and $q_0 = 0.5$.