A Multiwavelength Survey of Luminous Compact Blue Galaxies from z=3 to z=0

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Abstract. Luminous Compact Blue Galaxies (LCBGs) are small starburst systems that dominate the number density of galaxies at intermediate redshifts. LCBGs have evolved more than any other galaxy class in the last 8 Gyrs and are a major contributor to the observed enhancement of the UV luminosity density of the universe at z ¡ 1. Despite the key role LCBGs may play in galaxy evolution, their statistical properties are still largely unknown. We are currently conducting a multiwavelength study of LCBGs from z = 3 to the present, ranging from FUV to FIR. This study is unique in combining the capabilities of space observatories with ground-based large telescopes and large public databases of galaxy surveys. The main goals of this study are: (i) to characterize the global properties of LCBGs at 0 ¡ z ¡ 3 using statistically representative samples defined using the same selection criteria and over the same rest-frame wavelength range; and (ii) to investigate the role of this important population in galaxy formation and evolution.

1 Introduction

In the last few years, there has been substantial progress in our understanding of the numerous faint blue galaxies seen in deep images of the sky. The breakthrough came with the advent of HST and the new generation of 10-m class telescopes, which provided a detailed study of their morphology, internal kinematic, and mass. In particular, Keck spectra show that their emission-line velocity widths are only ≤ 60 km s^{-1} [16] [9], while their HST images reveal complex, distorted and knotted structures with typical half-light radii $r_e \leq 0.5''$, or $R_e \leq$ 3Kpc [11]. The combined Keck and HST data indicate that these distant galaxies, although being intrinsically luminous ($\sim 0.2 - 5L^\star$), have mass-to-light ratios that are only $\sim 0.1 - 1.0 M_\odot/L_\odot$, i.e., *about 10 times smaller than a typical* $L^\star$ *galaxy today* [20] [10]. The low mass-to-light ratios are consistent with these galaxies being small but vigorously star-forming systems. Jangren et al. [14] find that most of these starbursts can be isolated quantitatively on the basis of their luminosity, color, and surface brightness as a class distinct from normal Hubble-types found in similarly bright samples in the nearby universe. We refer to such class as “Luminous Compact Blue Galaxies” (LCBGs).

The nature of LCBGs and their relation to today’s galaxy population still remain largely unknown. The most comprehensive study of LCBGs at intermediate redshift to date –only 45 objects– [20] [10] concluded that the LCBG class is populated by a mixture of starbursts. About ∼60% of galaxies in their sample

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are classified as "HII-like" since they are similar to today's population of luminous, young, star-forming HII galaxies. The remaining ~40% are classified as "SB disk-like" since they form a more heterogeneous class of evolved starbursts similar to local starburst disk nuclei and giant irregular galaxies. This classification is consistent with previously published results for other LCBG samples. For instance, some authors [15] [16] [9] [11] have established the association between HII galaxies and LCBGs for their sample of compact narrow emission-line galaxies, while other studies [18] [13] have concluded that their LCBG samples can be best identified with bright irregulars, late-type spirals or disk galaxies with a young bulge.

Recently, various observational studies have highlighted the key role that LCBGs play in galaxy evolution over cosmological time-scales. For instance:

(i) *LCBGs contribute the most to the evolution of blue L^* galaxies in the last ~8 Gyrs:* the CFRS collaboration [17] first demonstrated that there is no significant evolution in the luminosity function of large galaxies (with typical sizes >8 kpc) all the way to $z \sim 1$. However, the number density of small but luminous stellar systems at $z > 0.5$ increase by a factor of ~10 compared to that observed at lower redshifts. In a follow-up study [18], they showed that this rapidly evolving population has global properties (i.e., blue colors, compact morphology, L^* luminosities, high SFR, small sizes, and small velocity widths) identical to those of LCBGs.

(ii) *LCBGs are a major contributor to the observed increase in the star formation rate density of the universe at $z < 1$:* we [10] have shown that LCBGs are responsible for ~45% of the observed enhancement in the global star formation density of the universe at $z \sim 1$. Such galaxies contribute a negligible amount to the local rest-frame blue luminosity density [19] but equal the contribution of regular spirals at $z \sim 1$ [1].

2 Description of the LCBG Survey

We are currently carrying out an extensive multiwavelength study of LCBGs from $z \sim 3$ to the present epoch. Our study will include observations ranging from far-UV to far-IR at high redshifts, and from far-UV to cm wavelengths at $z \sim 0$. The main goals are:

(1) to characterize the global properties of LCBGs as a class using statistically representative samples defined using *the same selection criteria* and over *the same rest-frame wavelength range* from $z \sim 3$ to $z = 0$. In particular we will:

• investigate their morphology, surface brightness, half-light radius, and color profile at various wavelengths. Systematic differences among FUV, optical and near-IR morphologies and structural parameters will allow us to study the spatial distribution and relative contribution of the young starburst and the underlying older population, as well as the extent and effect of dust extinction.

• measure their emission spectral features in the rest-frame wavelength range 1000-8000Å, including Lyα, [OII]3727, Hβ, [OIII]4959,5007, Hα, [NII], [SII], as