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Low Surface Brightness Galaxies Around the Hubble Deep Field South

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Abstract. We present results from a study of the SFH of a sample of LSB galaxies around the HDF-S. For the selection of the LSB galaxy candidates we used color–color diagrams, from which we selected the candidates based on their different location in comparison to the HSB galaxy redshift tracks. We compared measured spectra to synthetic SEDs from synthesis evolution models. We were able to fit SEDs in the range of 2 to 5 Gyr to the spectra of the LSB galaxies, while applying the same method to a sample of HSB galaxies resulted in an averaged stellar population of about 10 to 14 Gyr. Therefore, LSB galaxies tend to show much younger averaged stellar populations. This implies that the major star formation event of LSB galaxies took place at a redshift of z $\sim$ 0.2 to 0.4 while for HSB galaxies this tends to be at z $\sim$ 2 to 4.

Keywords. galaxies: general, galaxies: evolution

1. Introduction

LSB galaxies cover a large parameter space in luminosity, color, and HI mass. They appear in all morphological types. The only distinctive characteristic of this galaxy class is their low surface brightness. Late type LSB galaxies have diffuse, low-density stellar disks with a central surface brightness fainter than 22.5 mag arcsec^{-2} in the Johnson B-Band and exponential luminosity profiles. Large search programs for LSB galaxies in recent years have shown that these galaxies represent an important part of the galaxy population, possibly up to 60 % (Minchin *et al.* 2004). To understand galaxy formation and evolution as a whole, it is therefore essential to understand formation and evolution processes of these diffuse objects. Our LSB galaxy sample was derived in a 0.59 deg^2 field centered on the HDF-S (Haberzettl *et al.* 2007a,b) by selecting the LSB candidates due to their location in the color-color diagram. In this diagram the LSB galaxies have different location compared to HSB galaxies represented by the redshift tracks. This different location indicates already that LSB galaxies contain a different stellar population mix and therefore a different SFH. Accounting for spectroscopic distances our selection resulted in a sample of 5 LSB galaxies (9 deg^{-2}) which is a 2.5 times higher number density compared to other survey (e.g. Texas Survey, O'Neil *et al.* (1997a,b)). For our sample we then derived Spectral Energy Distributions (SED) in the range of 350 to 700 nm, using the ESO 3.6 m telescope.

2. Results

To derive the SFH of the LSB galaxy sample we compared the measured spectra to SEDs from a library of synthetic spectra from the synthesis evolution program PÉGASE (Fioc & Rocca-Volmerange 1997) derived using different ages and different star formation laws (expon., const. SFR and star burst). As input parameter we have chosen a Salpeter

IMF (Salpeter 1955) and a mass range from 0.08 M. to 80 M.. We do not include any inflow and outflow of matter. The PÉGASE SEDs were produced for consistent chemical evolution. Therefore, the metallicity is not a free parameter any more. Using PÉGASE we were also able to calculate synthetic SEDs including extinction for different geometries (spherical geometry, disk geometry for different inclination angles). Finally our library consists of more than 3100 theoretical SEDs which we compare to the measured spectra of galaxies. Due to the relatively low signal to noise ratios of the HDF-S LSB spectra we performed the search for the best fitting model SED by eye. The LSB spectra are all represented by an exponential decreasing SFR. The decay time was estimated to be 500 Myr (2 cases), 1400 Myr (3 cases), and 5000 Myr (2 cases). For the HDF-S sample we derived ages of the dominant stellar population between 1.4 Gyr and 5 Gyr. Only one candidate show slightly older dominant stellar population of about 7 Gyr. Our result is consistent with the results for the nearby dwarf LSB galaxy IC 1613 Skillman *et al.* 2003). They also find an enhanced SFR at ages between 3 to 6 Gyr based on detailed analyzes of the color-magnitude diagram. As a comparison sample we analyzed the HSB galaxies of the Kennicutt (1992) sample using our synthetic SED library and the same analysis methods. For the majority (60 %)of these HSB galaxies we find ages of the dominant stellar population of more than 5 Gyr. This result is also consistent with other studies of the SFHs of HSB galaxies (e.g. Terlevich & Forbes (2002), Caldwell *et al.* (2003)) This result indicates that the LSB galaxies underwent their major star formation event at much later stages (z∼0.2 to 0.4) compared to HSB galaxies (z∼2 to z∼4).

Conclusion:

- LSB galaxies populate a distinct region in some color-color diagrams, offset from the locus of HSB galaxies.
- SED analyses show that LSB galaxies have a younger dominant stellar population (younger than 5 Gyr) compared to HSB galaxies (older than 5 Gyr).
- LSB galaxies underwent their major star formation event at much later stages (around z∼0.2 to 0.4) compared to HSB galaxies (around z∼2 to 4).
- The young mean ages and the low metallicities explains the offset of LSB galaxies in the color-color diagrams and indicate that the LSB nature is the result of being relative unevolved.

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