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The hosts of blue compact dwarf galaxies in MaNGA

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Abstract. Blue compact dwarf galaxies(BCDs) are galaxies undergoing violent burst of star formation in compact regions. They are often thought of being an evolutionary stage of dwarf galaxies and thus can provide a unique window to study the formation and evolution of dwarf galaxies. We selected a sample of 48 BCDs from the SDSS-IV MaNGA survey (MPL-7) and separated the starburst(SB) components from their underlying hosts with a new algorithm. Combining the structural properties of the BCDs, we further explore the physical connections between the SB components and theirs hosts.

Keywords. galaxies: starburst, galaxies: dwarf, galaxies: structure, galaxies: fundamental parameters

1. Introduction

Blue compact dwarf (BCD) galaxies are narrow emission line dwarfs that are undergoing violent burst of star formation in compact regions, and have low intrinsic luminosities ($M_B > -18$ mag) and low gas-phase metallicities ($7.1 \leq 12+\log(\mathrm{O/H}) \leq 8.3$). The possible evolutionary pathways between various types of dwarf galaxies is still not fully understood. Many suspect that BCDs have evolutionary connections with other types of dwarf galaxies, different only in having a burst of recent star formation. To prove this, many work have attempt separating the starburst (SB) component from the underlying hosts of BCDs using the surface brightness profile, then compare the structural properties of the underlying hosts (e.g., the central surface brightness μ_0 and the effective radius re of the host component) with that of dIs and dEs (e.g., Amorín *et al.* 2009, Gil de Paz & Madore 2005, Meyer *et al.* 2014, Papaderos *et al.* 1996a, Papaderos *et al.* 1996a,b).

However, this kind of decomposition process usually assumes a functional profile as a prior, e.g., a Gaussian SB components overlays on an exponential disk, which might not suitable for all the cases, particularly for dwarfs. In addition, there are some difficulties of the photometry analysis: i) it suffers from strong emission lines contamination. ii) it is not easy to deal with the BCDs with noncentrally concentrated star forming regions. iii) no metallicity and no kinematic information are available and can be used for the decomposition.

Based on MaNGA IFU spectroscopy data, we can build so far the largest BCDs 3D spectral sample and dwarf comparison sample. Based on the spectral analysis, we can separate the SB from their underlying host component with a new algorithm. The advantages of IFU analysis are: i) emission lines can be easily removed; ii) we can estimate the SB component in a more physical way, without assuming any geometric shape of SB component; iii) we can also have the gaseous metallicity map, the gaseous and stellar kinematic map, which can help us to understand the whole formation scenario.

By analysing the 3D spectra data, we want to explore:

– the scaling relation of the structural properties of BCD hosts using our new sample and the new decomposition method.

– the sustaining timescale of the recent starburst.

– the possible physical connections between the SB components and their hosts.

2. Sample selection

MaNGA have internally released 4706 galaxies' 3D datacube (MPL-7). We calculated the average surface brightness within r_{50} using SDSS photometry information, and selected 48 BCD candidates by following criteria:

– be blue: $\langle\mu_g\rangle_{r_{50}} - \langle\mu_r\rangle_{r_{50}} < 0.4$

– be compact: $\langle\mu_g\rangle_{r_{50}} < 22$ mag/arcsec^2

– be dwarf: $M_z > -19$ mag

3. Method

To decompose the SB and host components, we do not assume any geometric shape of SB component in advance, but take advantage of the H_α map we got.

Our method consists of four main steps:

(*a*) We estimate the recent star formation rate (SFR) at each spaxel through the dust-corrected H_α emission line flux.

(*b*) By assuming a sustaining timescale τ_{SB} (1 to 100 Myr) of a constant SFR, we can estimate the stellar continuum spectra of the SB component at each spaxel through the stellar population synthesis model (the blue thick solid lines in Fig 1, assuming $\tau_{SB} = 7$ Myr).

(*c*) To get the 3D spectra datacube of the host, we subtract all the emission lines and the dust-redden SB continuum from the original spectra at each spaxel (the red thick dashed lines in Fig 1).

(*d*) We use `galfit` to fit the 2D surface brightness profile μ_g of the host component.

Following the above process, we can get the structural properties (μ_0, r_e, b/a, etc.) of the host and the estimation of recent starburst timescale τ_{SB}.

4. Example: MaNGA 8313-1901

The MaNGA galaxy 8313-1901 is a notable BCD in our sample because of the big blue star forming region at outskirts (see SDSS image in Fig 1). Its stellar mass is $10^9 M_\odot$, and total SFR estimated from the H_α flux is $\sim 1.2\ M_\odot/yr$, showing an violent star forming burst. This offset SB clump has a size comparable to the r_{50} of the host galaxy ($\sim$ 2 arcsec), and metallicy shows 0.3 dex lower relative to the other regions in the galaxy. All these properties make 8313-1901 as an interesting target, and a good start of the whole project.

The preliminary results of MaNGA BCD 8313-1901 show that: i) our method could effectively remove the contamination of SB component (see Fig. 2); ii) an outskirt SB region could affect the measurement of host structure, e.g. b/a changes from 0.62 to 0.84 in this case; iii) the recent starburst has continued about 7 Myr (Ju *et al.* 2018).

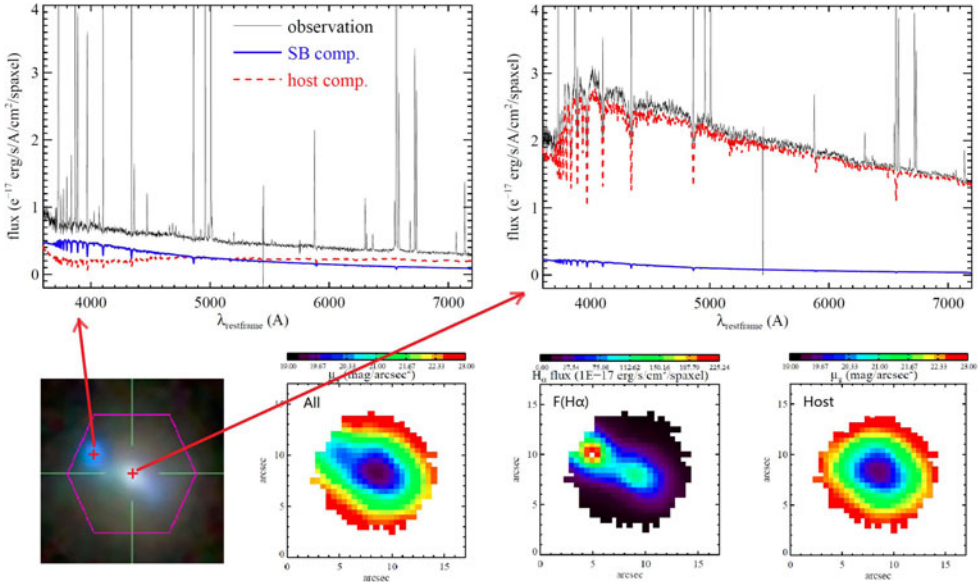

Figure 1. The components decomposition of MaNGA 8313-1901. The upper two panels show examples of the spectra decomposition in the center of the galaxy (upper right panel) and of SB clump (upper left panel). Thin black lines are the observed spectra, and thick blue solid lines and thick red dashed lines represent the SB components and host components respectively. From the left to right, the lower row shows the SDSS image, the g-band surface brightness map from the original datacube, the H_α flux map, and the g-band surface brightness map of the host component only.

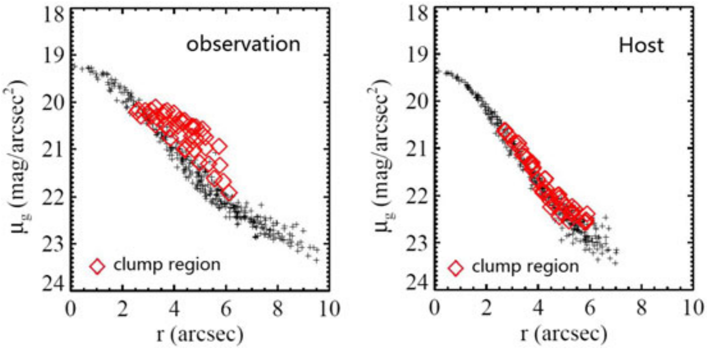

Figure 2. The radial profile of g-band surface brightness μ_g of 8313-1901. The left panel shows μ_g before removing the SB component, and the right panel shows μ_g of the host component only (assuming $\tau_{SB} = 7$ Myr). The red diamonds demonstrate the big blue clump region we see in the g-band image.

5. Summary

MaNGA offers the largest BCD 3D-spectral sample to date. It is the first time of using spectra data to decompose the SB and host components. We do not assume any geometric shape of the SB component. In this work, we will get the scaling relation of the structural properties of BCD hosts, and the formation timescale of recent SB. We want to explore the possible physical connections between the SB components and their host, and further discuss the evolutionary connections between dEs, dIs, and BCDs in same frame.

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