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The spectral properties of a large sample of low surface brightness disk galaxies

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Abstract. We present the spectral properties of a large sample of nearly face-on low surface brightness (LSB) disk galaxies selected from the SDSS-DR4 main galaxy sample. About 12,282 LSB galaxies have been selected from the photometry database with their B-band central surface brightness μ_0(B) ranging from 22 to 24.5 mag arcsec^{-2}. About 7000 of such LSBGs have measured emission lines ([OII]3727, [OIII]5007, Hβ, Hα, [NII]6583) with the S/N ratio greater than 5σ. Their spectral diagnostic diagram of [NII]/Hα vs. [OIII]/Hβ shows that ∼89% of them are star-forming galaxies, and ∼11% could be classified as AGNs. The relations of μ_0(B) vs. 12+log(O/H) and μ_0(B) vs. stellar masses M$_*$ of these star-forming LSB galaxies show that their O/H and M$_*$ increase following the increasing μ_0(B). The majority of these LSBGs are on the higher branch of metallicity.

Keywords. Galaxies: abundances, galaxies: evolution, galaxies: fundamental parameters, galaxies: spiral, galaxies: starburst

1. Introduction

The first quantitative suggestion about low surface brightness galaxies (LSBGs) is the so-called Freeman's law. It was noticed that the central surface brightness of 28 out of 36 disk galaxies of Freeman (1970) fell in the range of μ_0(B)=21.65±0.3 mag arcsec^{-2}. Some consequent surveys were searching for more LSBGs. However, the detected numbers were only several hundreds up to Impey *et al.* (1996) since the LSBGs emit much less light per area than the normal galaxies which make them to be found difficultly. The modern digital sky survey, such as the Sloan Digital Sky Survey (SDSS), must greatly improve the detected numbers of LSBGs, and could provide much more interests of them by taking advantage of the high quality photometric and spectral observations. We have selected a large sample of LSBGs from the main galaxy sample of SDSS-DR4 (12,282, named as Sample-L, see Zhong *et al.* in this proceedings). Some of their property parameters and correlations from photometry have been presented, as well as the hints for stellar populations from color-color diagrams. In this work, we will present the spectral properties of these LSBGs.

2. The diagnostic diagrams

About 7000 galaxies among the Sample-L were obtained their optical spectra by the SDSS with high quality, i.e., their [OII]3727, [OIII]5007, Hβ, Hα and [NII]6583 were detected with a signal-to-noise (S/N) ratio greater than 5σ. The distribution of them in the BPT diagram (Baldwin, Phillips, Terlevich 1981) was given in the first panel of Fig.1. The diagnostic diagram of [NII]/Hα vs. [OIII]/Hβ show that ∼89% of them are star- forming galaxies, and ∼11% could be classified as AGNs by using the diagnostic

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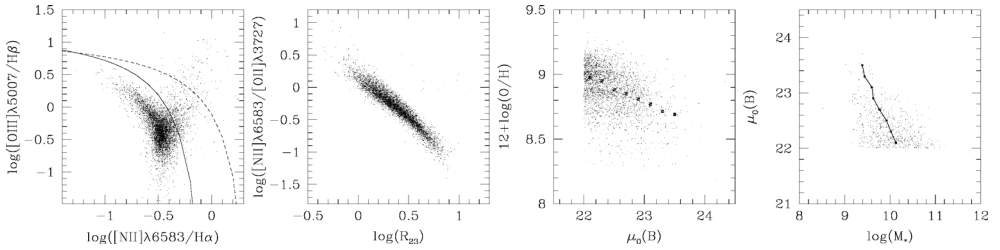

Figure 1. The properties of the large sample of LSBGs with high quality spectral observations selected from the main galaxy sample of SDSS-DR4: (*a*) [NII]/Hα vs. [OIII]/Hβ diagnostic diagram; (*b*) [NII]6583/[OII]3727 was plotted against the abundance indicating line ratio R_{23}; (*c*) The relations of μ_0(B) versus 12+log(O/H); (*d*) The relations of μ_0(B) versus stellar masses.

line from Kauffmann *et al.* (2003, the solid). The dashed line was taken from Kewley *et al.* (2001) to give the upper limit of the diagnostic relation.

In the second panel of Fig.1, [NII]6583/[OII]3727 was plotted against the abundance indicating line ratio R_{23} (=([OII]+[OIII])/Hβ) (McGaugh 1994). The transition through R_{23} turnover region for O/H occurs around log([NII]/[OII])~-1, so the majority of these LSBGs are on the higher branch of metallicity.

3. The relations of μ_0(B) versus O/H and μ_0(B) versus M$_*$

In the third panel of Fig.1, we present the relations of μ_0(B) vs. 12+log(O/H) of the star-forming LSBGs. It shows that the galaxies with larger μ_0(B) generally have higher metallicities. In the last panel of Fig.1, the relations of μ_0(B) vs. stellar masses M$_*$ of the star-forming LSBGs are given, which show that their M$_*$ increase following the increasing μ_0(B) generally. The lines in the two panels refer to the median values in the bins of 0.2 dex in μ_0(B).

4. Conclusions

We select a large sample of nearly face-on disk galaxies from the SDSS-DR4 main galaxy sample. Most of them are star-forming galaxies with strong emission lines. The majority of them are on the upper branch of metallicity with 12+log(O/H)>8.4 (logR_{23} < 0.8), i.e. not much metal-poor LSB galaxies were detected and obtained their spectra even in the SDSS survey. The LSBGs with higher μ_0(B) have higher metallicities and are more massive generally.

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