AN UPDATED ULTRAVIOLET CATALOG OF GALEX NEARBY GALAXIES

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ABSTRACT

The ultraviolet (UV) catalog of nearby galaxies compiled by Gil de Paz et al. presents the integrated photometry and surface brightness profiles for 1034 nearby galaxies observed by GALEX. We provide an updated catalog of 4138 nearby galaxies based on the latest Genral Release (GR6/GR7) of GALEX. These galaxies are selected from HyperLeda with apparent diameters larger than 1′. From the surface brightness profiles accurately measured using the deep NUV and FUV images, we have calculated the asymptotic magnitudes, aperture (D25) magnitudes, colors, structural parameters (effective radii and concentration indices), luminosities, and effective surface brightness for these galaxies. Archival optical and infrared photometry from HyperLeda, 2MASS, and IRAS are also integrated into the catalog. Our parameter measurements and some analyses are consistent with those of Paz et al. The (FUV − K) color provides a good criterion to distinguish between early- and late-type galaxies, which can be improved further using the concentration indices. The IRX−β relation is reformulated with our UV-selected nearby galaxies.

Key words: atlases – galaxies: fundamental parameters – galaxies: photometry – ultraviolet: galaxies

Supporting material: machine-readable tables

1. INTRODUCTION

Nearby galaxies (z ≲ 0.1) are characterized by large angular scale and high apparent brightness, which can be studied in greater detail and with higher accuracy than high-redshift galaxies. Ultraviolet (UV) imaging provides unique information for nearby galaxies. Massive, young stars emit strong UV energy that dominates the integrated UV light of star-forming galaxies. Thus, the UV flux is widely used as an excellent and accurate measurement of the current star formation rate (SFR; Kennicutt 1998; Wikins et al. 2012; Lanz et al. 2013). In addition, interstellar dust can absorb UV light and then re-emit it at far-infrared (FIR) wavelengths. The comparison between infrared and UV emission can effectively trace the dust attenuation in galaxies. Radiative transfer models suggest that the ratio of far-infrared to UV luminosity can be reliably used to estimate the dust attenuation (Buat & Xu 1996; Witt & Gordon 2000; Panuzzo et al. 2003), depending weakly on the geometry of stars and dust, the extinction law, and the stellar population.

The UV galaxy samples in the local universe are important for understanding the evolution of galaxies with cosmic time (Martin et al. 2005; Bouwens et al. 2012; Reddy et al. 2012; Ellis et al. 2013). There have been many attempts to explore SFR, morphology, dust attenuation, and evolution by constructing UV-selected local galaxies (Calzetti et al. 1994; Kuchinski et al. 2000; Marcum et al. 2001; Buat et al. 2002; Sullivan et al. 2004; Lauger et al. 2005).

Based on GALEX Public Release 2 and 3 (GR2/GR3), Gil de Paz et al. (2007) hereafter GALEX Atlas presented a UV catalog of 1034 nearby galaxies selected from the Third Reference Catalog of Bright Galaxies (RC3; de Vaucouleurs et al. 1991). They selected those galaxies whose optical diameters of μR = 25 mag arcsec−2 isophote (D25) are larger than 1′. The FUV and NUV images were mainly taken from GALEX Nearby Galaxies Survey (NGS). From the surface brightness profiles, they obtained asymptotic magnitudes, colors, and concentration indices. In combination with archival optical and infrared data, they analyzed the color−magnitude and color−color diagrams, the relations between colors and morphologies, the IRX−β relation, dust attenuation, and structural properties for different types of galaxies.

In 2013 February, GALEX GR7 data was made available. This catalog includes more than 45,000 images, almost three times larger than GR2/GR3. With deeper observations (up to 250 kiloseconds), it is now possible to create a relative complete UV sample of nearby galaxies. In this work, we provide an updated UV catalog of nearby galaxies with the deepest FUV and NUV images from GR6/GR7 as well as archival optical and infrared photometry, and we perform a similar analysis to that of Gil de Paz et al. (2007).

In Section 2, we present our sample selection of nearby galaxies. In Section 3, the method of measuring the surface brightness profile is described in detail. The catalog content including the UV parameters and other archival data are described in Section 4. The parameter comparison of our catalog with the GALEX Atlas is shown in Section 5. Section 6 presents some analyses and application examples of our catalog. The summary is in Section 7. All of the magnitudes presented in this paper are corrected for Galactic extinction using the Galactic Reddening Map of Schlegel et al. (1998). We use the reddening law of Cardelli et al. (1989) to convert E(B − V) to the UV extinction: A_{FUV} = 7.9 E(B − V) and A_{NUV} = 8.0 E(B − V).

2. SAMPLE SELECTION

The nearby galaxies in this paper are extracted from HyperLeda1 (Paturel et al. 2003; Makarov et al. 2014). HyperLeda is a catalog of extragalactic sources that provides accurate coordinates of objects (typical accuracy better than 2″), morphological parameters (e.g., size, axis ratio, position

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1 http://leda.univ-lyon1.fr, revised in 2013 July 1.
angle, morphological type, etc.), and astrophysical parameters (optical magnitudes and colors, surface brightness, distance, kinematic quantities, etc.). It includes 3.7 million galaxies, which is much more than RC3 as used by Gil de Paz et al. (2007). The catalog provides Doppler distances for 20,314 galaxies and redshift-independent distances for 2013 galaxies. Figure 1(a) shows the distributions of the major-axis diameters in both the HyperLeda and RC3 catalogs, while Figure 1(b) presents the same distributions but with $D25 > 1'$. The majority of HyperLeda galaxies have diameters less than $1'$, and over 99% of RC3 galaxies are included in HyperLeda. There are more HyperLeda galaxies with diameters above $1'$ by a factor of 3 than those of RC3.

We adopt the same criterion of optical diameters as used by Gil de Paz et al. (2007), that is, $D25$ is larger than $1'$. There are 22,948 galaxies satisfying this constraint. We retrieve the FUV and NUV images for these galaxies from GALEX GR6/GR7 to obtain their intensity maps. Three imaging surveys are involved: the Medium Imaging Survey, NGS, and the Deep Imaging Survey (DIS). We require the galaxies ($1.5 \times D25$) to be fully covered by the GALEX field of view (FOV; $1'2$ in diameter). Those galaxies that have a low signal-to-noise ratio or are contaminated by surrounding galaxies and bright stars are excluded. The optical diameter $D25$ of M31 is about $3'0$, which is far beyond the GALEX FOV. We obtain 26 tiles of M31 in FUV and NUV from NGS and DIS, which are stacked to form very deep mosaics by Montage. The final sample contains 4138 galaxies, 2321 of which have both FUV and NUV observations. There are 14 and 1803 galaxies having only FUV and NUV observations, respectively.

We present their basic parameters as given by HyperLeda in Table 1, including the positions, sizes, morphological types, and distances. For galaxies whose distances are not available, we get their distances from NED (the NASA/IPAC Extragalactic Database). There are 4047 galaxies with either luminosity distances or redshift-dependent distances.

Figure 2 shows the normalized distributions of the $D25$ diameter, morphological type, and distance in the GALEX Atlas and in our sample. In contrast, our sample provides more galaxies with smaller diameters, earlier types, and larger distances.

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### Table 1

| PGC | R.A. (J2000.0) | decl. (J2000.0) | $2\times A$ (arcmin) | $2\times B$ (arcmin) | P.A. (deg) | $T$ | Distance (Mpc) |
|-----|---------------|----------------|----------------------|----------------------|------------|----|----------------|
| 12  | 00 00 08.604  | −06 22 26.00  | 1.4  | 0.3  | 168 | 1.3 ± 1.0 | 95 |
| 62  | 00 00 46.908  | −77 34 47.93  | 1.0  | 0.2  | 9   | 4.4 ± 1.9 | 153 |
| 120 | 00 01 38.316  | +23 29 00.92  | 1.9  | 1.1  | 160 | 5.3 ± 1.5 | 52 |
| 129 | 00 01 41.916  | +23 29 44.95  | 1.4  | 0.5  | 135 | 4.8 ± 1.4 | 65 |
| 143 | 00 01 58.188  | −15 27 39.24  | 10.5 | 3.5  | 5   | 9.9 ± 0.3 | 0.97 |
| 176 | 00 02 34.836  | −03 42 38.92  | 1.1  | 0.7  | 180 | 4.0 ± 0.5 | 93 |
| 192 | 00 02 48.624  | −03 36 21.82  | 1.1  | 0.3  | 25  | 5.0 ± 2.0 | 90 |
| 215 | 00 03 14.184  | −65 22 11.68  | 1.1  | 0.5  | 167 | 4.4 ± 1.9 | 90 |
| 243 | 00 03 32.148  | −10 44 40.81  | 1.1  | 1.0  | ... | −2.0 ± 0.6 | 129 |
| 250 | 00 03 34.992  | +23 12 02.92  | 1.0  | 0.6  | 23  | 5.5 ± 0.8 | 107 |

Note. The parameters are taken from HyperLeda. For galaxies whose distances are not available, their distances are selected from NED. Column (1): PGC number. Columns (2)-(3): R.A. and decl. (J2000.0) of the galaxy center. R.A. are in hours, minutes, and seconds, and decl. are in degrees, arcminutes, and arcseconds. Column (4): major-axis diameter of the $D25$ ellipse. Column (5): minor-axis diameter. Column (6): position angle (P.A.). Column (7): morphological type $T$ and its error. Column (8): distance in Mpc.

(This table is available in its entirety in machine-readable form.)
3. SURFACE BRIGHTNESS MEASUREMENT

GALEX provides sky background-subtracted images, but the background near the galactic center is overestimated, especially for galaxies with large apparent sizes. We introduce a new procedure to better estimate the sky background, which is quite similar to the method in Zou et al. (2011). SExtractor (Bertin & Arnouts 1996) is used to separate source pixels from background pixels. The source pixels, together with the region with a galactocentric distance of \( r < 2 \times D_{25} \), are masked. Then, the remaining pixels are fit with a two-dimensional polynomial function to generate the background map. Finally, the fitted map is subtracted from the intensity image.

Foreground stars contaminate the galaxy flux and need to be masked in the intensity map. We obtain the point sources (mostly stars) within the image from GALEX photometric catalogs. The mask aperture is determined by the growth curve where the corresponding aperture magnitude is close to the total magnitude presented in the catalog. However, the cataloged point sources might include some star formation regions whose UV color is much bluer than normal stars. Since the number of star formation regions is strongly dependent on the galaxy type, we separate our entire sample into two subsamples according to morphological type: one with \( T \geq -0.5 \) identified as spiral/irregular galaxies (types from Sa to Irr) and the other with \( T < -0.5 \) identified as elliptical/lenticular galaxies (types from E to S0a). For early-type galaxies, all point sources detected by GALEX are regarded as foreground stars and are masked. For late-type galaxies, we only mask those point sources with \( (FUV - NUV) > 1 \), and keep bluer point sources with \( (FUV - NUV) < 1 \) as star-forming regions. The nuclei of galaxies, also point-like, are not masked. For galaxies with single UV-band observations, we define foreground stars by visually inspecting both the UV image and the color image of the Digitized Sky Survey.

We then use the MATLAB package of astronomy and astrophysics for the measurement (Ofek 2014). The radial surface brightness profile is computed with a series of elliptical annuli whose major radii range from \( 3'' \) to at least 1.5 times the \( D_{25} \) radius. The brightness errors are estimated with the method used in Gil de Paz & Madore (2005). Figure 3 shows some examples of the false color images and surface brightness profiles of galaxies in our sample. The radial \( (FUV - NUV) \) color profile is also plotted.

4. THE CATALOG CONTENT

4.1. Asymptotic and D25 Magnitudes

We adopt the technique introduced by Cairós et al. (2001) to calculate the asymptotic magnitudes. First, the accumulated flux and the gradient of the growth curve at each radius are computed. Then, an appropriate radial range away from the galaxy center is visually chosen where an error-weighted linear fit to the relation of accumulated flux versus the gradient of the growth curve is performed. Finally, the intercept of this linear fit is regarded as the asymptotic magnitude, and the corresponding magnitude error is derived from the error of the linear fit.

We also calculate the aperture magnitudes inside the D25 ellipses. The errors are estimated from the random noise inside the apertures and the uncertainties of the sky background subtraction (see Gil de Paz & Madore 2005). Not all of the errors include the uncertainty of NUV and FUV photometric zeropoints, which are about 0.15 and 0.09 mag, respectively.

4.2. Effective Surface Brightness and Concentration Indices

Based on the growth curve, we derive the radii containing 50%, 20%, 25%, 75%, 80% of the total luminosity \( r_{25}^{eff}, r_{20}^{eff}, r_{75}^{eff}, r_{80}^{eff} \), respectively. The effective surface brightness is calculated as \( I = 0.5L_{FUV}/\pi r_{eff}^2 \), and the concentration indices are calculated as \( C31 = r_{75}/r_{25} \) and \( C42 = 5\log(r_{80}/r_{20}) \) (de Vaucouleurs 1977; Kent 1985).

4.3. Archival Optical and Infrared Data

Multi-wavelength data for nearby galaxies could improve our understanding of their physical nature. We add some corollary data from other optical and infrared surveys into our catalog. HyperLeda provides the total \( B \) magnitude \( (B_T) \) and the total \( I \) magnitude \( (I_T) \). A total of 4064 galaxies have \( B_T \) magnitudes and 3265 galaxies have \( I_T \) magnitudes. There are 640 and 813 galaxies in our sample with \((U - B)_T \) and \((B - V)_T \) colors, respectively. In the near-infrared, we compile \( JHK \)-band photometry from the 2MASS Large Galaxy Atlas (LGA; Jarrett et al. 2003). If galaxies are unavailable in LGA, \( JHK \) photometry in the 2MASS Extended Source Catalog (XSC) are used. A total of 3708 galaxies have \( JHK \) magnitudes. In mid-infrared (MIR) and FIR, the photometry in 12, 25, 60, and 100 \( \mu \)m are obtained from IRAS. We follow the priority given by Gil de Paz et al. (2007) to compile the photometry (Rice et al. 1988; Moshir et al. 1990 and the IRAS Point Source Catalog). The 60 and 100 \( \mu \)m are used to estimate the
far-infrared emission. There are 1570 galaxies with infrared fluxes in both 60 and 100 μm. The UV properties and archival optical and IR data are presented in Tables 2 and 3, respectively.

5. COMPARISON WITH GALEX ATLAS

We show photometric comparisons between the GALEX Atlas and our sample in Figure 4. Figures 4(a)–(d) display the differences in asymptotic and aperture magnitudes between our catalog and the GALEX Atlas. There are 94% and 93% of galaxies in the FUV and NUV with a difference in asymptotic magnitudes within 0.5 mag. We check those galaxies with differences larger than 0.5 mag and find that these differences might be caused by the different sky background estimation and elliptical parameters inherited from their parent catalogs. We fit a sky background map for each galaxy, while the GALEX Atlas only uses a single background value. For example, the average background of PGC 4085 (ESO 243-
G041) given by the GALEX Atlas is $5.59 \times 10^{-4}$ counts s$^{-1}$ in the NUV, while the average value of our computed background is $2.24 \times 10^{-3}$ counts s$^{-1}$, which leads to a magnitude difference of 0.59. After checking the intensity image, our fitted background is more reasonable, since the flux of no-signal area around the galaxies is about $2 \times 10^{-3}$ counts s$^{-1}$. There are many galaxies in the GALEX Atlas and our sample with different axis ratios and D25 diameters. When galaxies become fainter, the difference in the axis ratios can reach a factor of 9, which leads to different growth curves and results in different magnitudes. For example, the axis ratio of PGC 4190 (NGC 0407) given by HyperLeda is 6.9, while the GALEX Atlas gives 4.3. These differences lead to the different magnitude differences between GALEX Atlas and our sample.

Figures 4(e) and (f) show the differences between the (FUV – NUV) colors of asymptotic and aperture magnitudes. The colors of our sample are consistent with those in the catalogs of the GALEX Atlas with standard deviations of 0.19 and 0.13 for asymptotic and aperture colors, respectively.

The differences in the concentration indices for the two samples are displayed in Figures 4(g) and (h). The concentration indices in both FUV and NUV of our samples are on average smaller than those in the GALEX Atlas, probably due to the differences between the growth curves.

6. ANALYSES AND SOME APPLICATIONS

6.1. UV Properties of the Galaxies

Figure 5 shows the distributions of UV properties of the galaxies in our catalog. Figures 5(a)–(g) present the histograms of asymptotic magnitudes, morphological type, luminosities, (FUV – NUV) colors, effective radii, and concentration indices. The median asymptotic magnitudes in FUV and NUV are 17.55 and 17.20 mag, respectively. In our sample, about 5% of galaxies show asymptotic magnitudes larger than D25 magnitudes. For these galaxies, the diameters corresponding to asymptotic magnitudes are smaller than the D25 diameters due to the lack of diffuse emission. The residual flux after background subtraction within D25 ellipses leads to additional UV flux in the D25 magnitudes.

There are 1030 (25%) and 2899 (70%) early- and late-type galaxies (Figure 5b), and 209 (5%) galaxies without morphological types given by HyperLeda. Figure 5(c) presents the luminosity distributions. The median FUV and NUV luminosities are $7.8 \times 10^{4}$ and $9.1 \times 10^{5} L_{\odot}$ ($3.0 \times 10^{55}$ and $3.5 \times 10^{55}$ W), respectively. Ten galaxies in our catalog are ultraviolet-luminous galaxies (UVLGS; Heckman et al. 2005), defined as having FUV luminosities larger than $2 \times 10^{10} L_{\odot}$ ($7.6 \times 10^{36}$ W), which are extremely rare in the local universe. Among the 10 galaxies, PGC 2248, 36466, and 59214 have been identified by the GALEX Atlas. PGC 53898 and 71035 are Seyfert galaxies (Véron-Cetty & Véron 2006), PGC 4007 and 17625 are luminous infrared galaxies (Sanders et al. 2003; Haan et al. 2011). The other three galaxies, PGC 23064, 30400, and 51865, are star-forming spiral galaxies with very UV-luminous arms. PGC 70348 (NGC 7469) is defined as a UVLG in the GALEX Atlas but does not qualify in our sample. Our FUV luminosity of this galaxy is about $7.3 \times 10^{36}$ W, which is close to the threshold.

Figure 5(d) presents the color distributions of asymptotic and D25 magnitudes. The majority of galaxies have colors bluer than (FUV – NUV) = 1, which has been used to separate foreground stars. The red tail of the distributions is populated by early-type galaxies. The distributions of effective radii in kiloparsecs are shown in Figure 5(e). The median effective radii for FUV and NUV are 4.3 and 5.0 kpc, respectively. The distributions and comparisons of concentration indices are presented in Figures 5(f)–(i). The galaxies are on average slightly more concentrated in the NUV than in the FUV by differences of 0.03 in C31 and 0.10 in C42, which may be due to the different fractions of the bulge component in spiral galaxies in these two bands (Gil de Paz et al. 2007). Figure 5(j) shows the color as a function of the FUV magnitude. The late-type galaxies are brighter and bluer than the early-type galaxies. PGC 70348 is de ned as having FUV magnitude. The late-type galaxies are brighter and bluer than the early-type galaxies. PGC 70348 is de ned as having FUV magnitude.

6.2. Effective Surface Brightness

The plot of effective surface brightness versus FUV luminosity is presented in Figure 6. This figure shows a trend
Table 3
Achival Optical and Infrared Data in Our Catalog

| PGC | B (mag) | I (mag) | (U - B)_T (mag) | (B - V)_T (mag) | J (mag) | H (mag) | K (mag) | 12 μm (Jy) | 25 μm (Jy) | 60 μm (Jy) | 100 μm (Jy) |
|-----|---------|---------|-----------------|-----------------|---------|---------|---------|-------------|-------------|------------|-------------|
| 12  | 14.66 ± 0.38 | ...     | ...             | ...             | 12.10 ± 0.03 | 11.38 ± 0.04 | 11.11 ± 0.06 | ...         | ...         | ...        | ...         |
| 62  | 16.23 ± 0.21 | 14.47 ± 0.08 | ...             | ...             | 13.48 ± 0.08 | 12.73 ± 0.09 | 12.61 ± 0.14 | ...         | ...         | ...        | ...         |
| 120 | 13.01 ± 0.41 | 11.29 ± 0.22 | ...             | ...             | 10.33 ± 0.02 | 9.59 ± 0.02  | 9.33 ± 0.02  | ...         | ...         | ...        | ...         |
| 129 | 13.59 ± 0.30 | 12.43 ± 0.22 | ...             | ...             | 11.06 ± 0.02 | 10.16 ± 0.02 | 9.93 ± 0.03  | <0.38       | <0.67       | 5.47 ± 0.66 | 14.29 ± 1.86 |
| 143 | 10.89 ± 0.08 | ...       | ...             | ...             | 0.40       | ...        | ...       | <0.12       | <0.20       | 0.32 ± 0.08 | 1.04 ± 0.26  |
| 176 | 14.33 ± 0.29 | 12.77 ± 0.08 | ...             | ...             | 11.86 ± 0.03 | 11.24 ± 0.04 | 10.82 ± 0.05 | <0.25       | <0.33       | 1.21 ± 0.12 | 2.49 ± 0.27  |
| 192 | 15.07 ± 0.36 | ...       | ...             | ...             | 12.37 ± 0.03 | 11.69 ± 0.04 | 11.56 ± 0.07 | ...         | ...         | ...        | ...         |
| 215 | 15.49 ± 0.29 | 14.38 ± 0.08 | ...             | ...             | 14.09 ± 0.12 | 13.23 ± 0.15 | 12.99 ± 0.17 | ...         | ...         | ...        | ...         |
| 243 | 14.37 ± 0.36 | 12.50 ± 0.32 | ...             | ...             | 0.81       | 11.25 ± 0.03 | 10.63 ± 0.03 | 10.30 ± 0.04 | 0.11 ± 0.03 | <0.21      | 0.37 ± 0.05 | 1.58 ± 0.21  |
| 250 | 14.05 ± 0.54 | 12.25 ± 0.10 | ...             | ...             | 11.51 ± 0.04 | 10.83 ± 0.05 | 10.66 ± 0.06 | <0.25       | <0.25       | 0.74 ± 0.07 | 3.64 ± 0.66  |

Note. Column (1): PGC number. Column (2): B-band total magnitude in Vega mag from HyperLeda. Column (3): I-band total magnitudes in Vega mag from HyperLeda. Columns (4)–(5): total asymptotic (U−B) and (B−V) colors from HyperLeda. Columns (6)–(8): 2MASS J, H, and K-band total magnitudes in Vega mag from (Jarrett et al. 2003) and the 2MASS Extended Source Catalog. Columns (9)–(12): IRAS12, 25, 60, and 100 μm fluxes in Jy from (Rice et al. 1988; Moshir et al. 1990) and the IRAS Point Source Catalog.

(This table is available in its entirety in machine-readable form.)
of slightly increasing effective surface brightness with increasing luminosity, indicating that galaxies with large effective radii turn out to be more luminous (Hoopes et al. 2007). The effective surface brightness distribution of our sample is more concentrated than in the Hoopes et al. (2007) sample, since the contours in Figure 6 enclose 96% of the galaxies in our sample but only 84% in their sample.

The compact UVLGs are UVLGs defined with a surface brightness of $I_{\text{FUV}} > 10^9 L_\odot$ kpc$^{-2}$ (Hoopes et al. 2007). They have characteristics that are remarkably similar to the Lyman break galaxies (LBGs), such as SFRs, metallicities, morphologies, kinematics, and attenuations (Basu-Zych et al. 2007; Hoopes et al. 2007; Overzier et al. 2008). Only 12 galaxies in our sample have the surface brightness $I_{\text{FUV}} > 10^9 L_\odot$ kpc$^{-2}$. Two of them, PGC 59214 and PGC 71035, have both high luminosity and high surface brightness, which can be classified as compact UVLGs. PGC 59214 is a BL Lac object and PGC 71035 is a Seyfert 1.5 (Véron-Cetty & Véron 2006). Both of these objects have very compact nuclei in the FUV, and the optically thick accretion disks around super-mass black holes probably dominate their FUV luminosity (Malkan & Sargent 1982; Ward et al. 1987; Sanders et al. 1989).

6.3. ($FUV - K$) Tracing Galactic Morphology

Compared to the optical colors (Weiner et al. 2005; Pozzetti et al. 2010; Talia et al. 2014), the combination of UV and IR should be more efficient in separating the early- and late-type galaxies, given their different SFRs and dust attenuation (Gil de Paz et al. 2007). Since the UV emission is very sensitive to the presence of recent star formation activity and the $K$-band emission is sensitive to the accumulated star formation (Muñoz-Mateos et al. 2007), the ($FUV - K$) color provides a robust discrimination between early- and late-type galaxies as analyzed by Gil de Paz et al. (2007).

Figure 7(a) shows the relation between ($FUV - K$) color and galactic morphology. Here, we convert the 2MASS $K$-band Vega magnitudes to the AB system by adding 1.84 mag (Cohen et al. 2003; Muñoz-Mateos et al. 2009). We calculate the dividing ($FUV - K$) color to separate early- and late-type galaxies by minimizing the number of galaxies that are misclassified by the dividing magnitude, which leads to
(FUV − K) = 6.84. About 68% of early-type galaxies and 86% of late-type galaxies are correctly classified. The (FUV − K) is linearly correlated to the morphology of late-type galaxies. The best linear fit to the relation (green line in Figures 7) is

\[(FUV - K) = (5.8 \pm 0.1) - (0.25 \pm 0.02) \times T. \quad (1)\]

Here, T is the morphological type given by HyperLeda and the errors of the parameters are derived from the linear fitting.

The concentration indices have also been used as a classification tool (Abraham et al. 1996; Bershady et al. 2000). The (FUV − K) color and concentration indices are expected to show a better separation of the different types galaxies, which is discussed in Gil de Paz et al. (2007). We present the FUV concentration index C42 as a function of the
Early-type galaxies have larger C42 and redder \((FUV - K)\) color in Figure 7(b). The best separation line in the plane of this figure is computed as

\[
(FUV - K) = 14.4 \pm 0.3 - (2.5 \pm 0.1) \times C42_{FUV}.
\]

With this, 76\% and 94\% of early- and late-type galaxies are correctly classified.

6.4. IRX–\(\beta\) Relation

The IR excess (IRX) is widely used as a good tracer of the dust attenuation in galaxies, and the slope of the UV continuum \((\beta)\) is considered as a proxy to estimate the IRX when IR data are not available, which is known as the IRX–\(\beta\) relation (Daddi et al. 2007; Reddy & Steidel 2009; Takeuchi et al. 2010). IRX is defined as \(\log(f_{FUV}/f_{FUV})\), where \(f_{FUV}\) is the total infrared flux and \(\beta\) can be estimated by \((FUV - NUV)\). Here, the IRX–\(\beta\) relation is not valid for early-type galaxies, since a substantial part of dust heating is due to photons emitted by old stars which do not emit primarily in UV and the dust attenuation would be overestimated by IRX (Buat et al. 2011).

Figure 8 shows the \((FUV - NUV)\) color against IRX for our late-type galaxies together with the local starburst relation derived from Meurer et al. (1999). Here, we define \(f_{FUV} = \lambda f_{\lambda}\) and adopt the formula proposed by Sanders & Mirabel (1996) to derive the \(f_{TIR}\), which is estimated using 12, 25, 60, and 100 \(\mu m\) from IRAS data. We separate our galaxies into two groups according to their FUV luminosities. In Figure 8, we can see that most of our galaxies are located below the relation of Meurer et al. (1999). The galaxies with brighter FUV luminosities \((L_{FUV} \geq 10^{35} W)\) have a tighter relation than that of fainter galaxies. Both groups have steeper IRX–\(\beta\) relations than that of Meurer et al. (1999). We linearly fit the relations of these two groups, which are formulated as

\[
\text{IRX} = (6.54 \pm 0.01) \times (FUV - NUV) - (2.10 \pm 0.01), L_{FUV} \geq 10^{35} W,
\]

(3)

\[
\text{IRX} = (2.76 \pm 0.05) \times (FUV - NUV) - (0.84 \pm 0.07), L_{FUV} < 10^{35} W.
\]

7. SUMMARY

In this paper, we provide an updated catalog of 4138 nearby galaxies based on the latest (GR6/GR7) of GALEX, which is more than three times the number of galaxies in the original GALEX Atlas. Our samples are selected from the extragalactic catalog of HyperLinda. The D25 diameter is set to be larger than 1'. Compared with the GALEX Atlas, we apply a more precise procedure to estimate the sky background in the GALEX images. Radial FUV and NUV surface brightness profiles are obtained. From these profiles, we calculate
asymptotic magnitudes, aperture (D25) magnitudes, UV colors, structural parameters (effective radii and concentration indices), luminosities, and effective surface brightness. We also augment our data set with archival optical and infrared photometry from HyperLeda, 2MASS, and IRAS. With this updated catalog, we confirm that the \((FUV −K)\) color provides a good criterion to distinguish between early- and late-type galaxies, which can be improved further with the concentration indices. The IRX−β relation is reformulated using our UV-selected nearby galaxies.

The GALEX images and catalogs of our nearby galaxies can be accessed via the website http://bate.bao.ac.cn/~zouhu/doku.php?id=projects:galax:start.

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![Figure 8. IRX−β relations for galaxies with \(L_{\text{FUV}} \geq \times 10^{35} \) W (left) and galaxies with \(L_{\text{FUV}} < \times 10^{35} \) W (right). The dashed curves show the IRX−β relation of starburst galaxies derived by Meurer et al. (1999). The solid lines are the robust linear fits to the relations of our samples.](image-url)
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