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IMPACT OF NEIGHBORS IN SDSS GALAXY PAIRS

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ABSTRACT

How galaxies are affected by their neighboring galaxies during galaxy-galaxy interactions is a long-standing question. We investigate the role of neighbors in galaxy pairs based on the SDSS data release 7 and the KIAS value-added galaxy catalog. Three groups of galaxies are identified: (a) galaxies with an early-type neighbor, (b) with a late-type neighbor, and (c) isolated ones with no neighbor. We compare their UV + optical colors and Hα emission as indicators of the recent star-formation rate (SFR). Given that galaxies show systematic differences in SFR as functions of morphology, luminosity, and large-scale environments, we construct a control sample in which the galaxies have the same conditions (in terms of morphology, luminosity, and large-scale environment) except for the neighbor's properties (i.e., morphology, mass, and distance). The results are as follows. (1) Galaxies with a late-type companion demonstrate more enhanced SFR than those with an early-type companion. (2) Galaxies with an early-type neighbor show NUV- and u-band derived SFRs that are even lower than that of isolated galaxies, while they have similar or slightly higher Hα-based SFR compared to isolated ones.

Key words: galaxies: evolution — galaxies: general — galaxies: interactions — galaxies: star formation

1. INTRODUCTION

The galaxy-galaxy interaction is one of the key factors in galaxy evolution. However, exactly how a galaxy is affected by its neighbors remains an open question. Galaxy pairs are important tools for the study of galaxy interactions, as we can easily regard any change in the galaxy's properties as being caused by interaction with a companion. The advent of large survey such as the Sloan Digital Sky Survey (SDSS; York et al. 2000) has enabled the exclusion of the undesirably peculiarty of individual galaxies.

Park et al. (2008) and Park & Choi (2009) showed that SDSS galaxies statistically resemble their neighboring galaxies' properties, including star formation rates (SFR). Meanwhile, it has been reported in many previous studies that star formation activity in close pair galaxies is increased by tidal force (Barton et al. 2000; Nikolic et al. 2004; Ellison et al. 2008). In this study, we will clarify the impact of neighbors on the SFR in comparison with a non-pair control sample, and reconcile the previous studies on galaxy pairs.

2. METHODOLOGY

Our galaxy sample is based on the Korea Institute for Advanced Study Value-Added Galaxy Catalog (KIAS VAGC; Choi et al. 2010). The KIAS VAGC provides morphological types of galaxies using the classification method of Park & Choi (2005), and has high spectroscopic completeness through the addition of redshifts from various catalogs including the NYU VAGC (Blanton et al. 2005) and SDSS DR7 (Abazajian et al. 2009).

We measure the UV+optical colors of galaxies from the SDSS optical and GALEX UV (Morrissey et al. 2007) photometric data. Optical and UV magnitudes are k-corrected to redshift 0.1 with Blanton's kcorrect v4_2 (Blanton et al. 2007).

The spectroscopic data are obtained from the OSSY database (Oh et al. 2011). We note that in our study, all AGN candidates are extracted using the BPT diagram to separate star formation activity from AGN emission.

Each galaxy is matched with its most influential neighboring galaxy. Within a projected radius of 200 h^{-1}kpc and a radial velocity difference of 300 km/s, the *influence* of neighbors are evaluated by tidal index $\Theta = M/R^3$, where M is the stellar mass of neighboring galaxies and R is the projected distance to neighbors (Karachentsev et al. 1999). The matched galaxy pairs can be classified by their respective morphological types into four different groups (E-E, L-E, E-L and L-L, e.g., E-L is a group of early-type galaxies with a late-type neighbor). We simply label galaxies with early-type neighbors as EP, and those with late-type neighbors as LP. Galaxies which have no neighbors within a given projected radius and radial velocity range are classified

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as non-pair galaxies (NP).

We construct a 'control' sample to analyze the impact of *neighbors* on star formation activities. Since our EP, LP and NP groups belong in different large-scale (few Mpc-scale) environments, they have systematic differences in their morphology and luminosity, and hence in mean SFRs. For our purpose, each group should have the same conditions, except for the neighbors properties. We thus make a control sample which is matched with criteria in terms of morphology, luminosity, redshift and large-scale environment parameters. As a result, we obtain 339,538 EP-LP-NP control sets.

3. RESULTS

We examine some SFR indicators for our control samples; the results are summarized in Figures 1 to 3

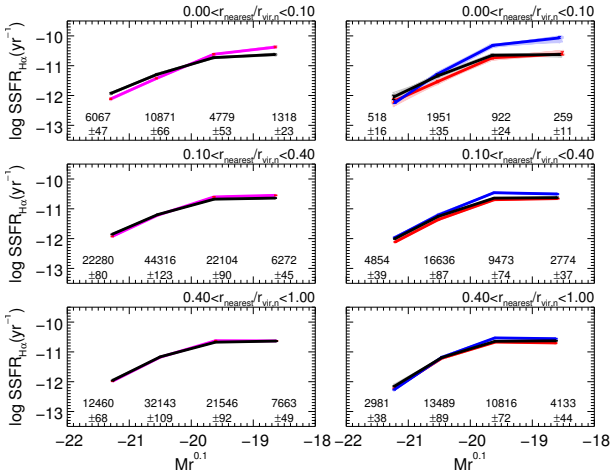

Figure 1. The median SSFR (the star formation rate per unit stellar mass) derived from Hα emission lines as a function of r-band luminosities. Each line color represent non-pair control sample (black), pair galaxy sample (magenta), EP sample (red) and LP sample (blue), respectively. Distance to the neighbor (normalized by the virial radius of neighbor) decreases from bottom to top. Because multiple control sample combinations can be created, we repeated making a control sample 100 times, so the pale colors show each of the trials, the deep color lines represent the medians with 1σ distributions of them, and numbers in panels indicate the median and standard deviation of the number of galaxies in each bin. The SSFR is enhanced in pair (LP) galaxies, and the same result had been already reported in many previous studies such as Barton et al. (2000), Nikolic et al. (2004), Ellison et al. (2008), etc.

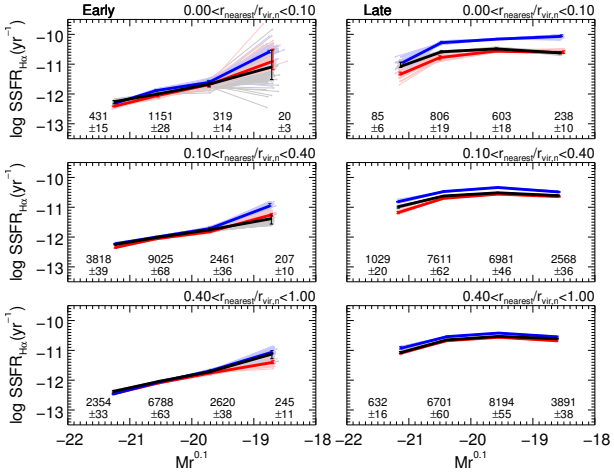

Figure 2. The median SSFR derived from Hα emission line as a function of r-band luminosities. Left panel show early-type samples and right panel show late-type samples, respectively. The format is the same as that of Figure 1. We can notice that only L-L galaxies clearly show enhanced SSFR, but E-L galaxies show no distinct SFR variation in comparison with NP control sample.

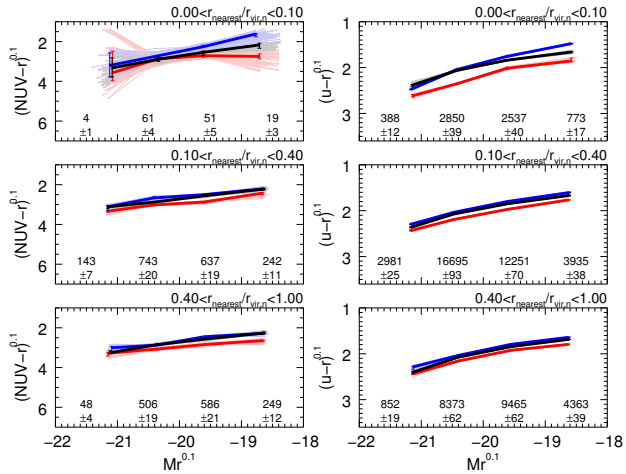

Figure 3. The median NUV-r color (left) and u-r color (right) of late-type galaxies as a function of r-band luminosities. The format is the same as that of Figure 1. In both color indices, faint L-L galaxies are bluer than NP galaxies but L-E galaxies appear even redder. It shows the SFR of late-type galaxies can be quenched when they have close early-type companion.

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