The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
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Gas inflow and nuclear star formation in galaxies with non-axisymmetric bulges

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Abstract. We present the dependence of the amount of nuclear star formation on the non-axisymmetry of a bulge of disk galaxies. For this, we use a volume-limited sample of spiral galaxies at $0.02 <= z < 0.055$ from the SDSS DR7. Among 3173 final sample galaxies with an axis ratio $b/a > 0.6$ and a bulge fraction ranged in $B/T <= 0.41$, nuclear starburst galaxies are 10 %. We find that a fraction of the nuclear starburst galaxies become higher when ellipticity of a bulge increases in early type galaxies. Also, the fraction increases clearly when early type galaxies are isolated and in low density region. Our results indicate that the non-axisymmetry of bulges assists gas to fall inside and affects the nuclear starburst process in disk galaxies.

Keywords. Galaxies:sprial — Galaxy:bulge — Galaxies: starburst

1. Introduction

Gas inflow in a galaxy is a key process during galactic evolution. The migration of gases takes place by tidal interactions and mergers or non-axisymmetric mass distribution in the galactic nucleus gravitational potential. A large amount of inward gas migration can induce nuclear star formation. In the second case, it is well known that non-axisymmetric bar torque drives gas inflows; however, research of a relation between non-axisymmetry of the bulge and nuclear star formation has not been well studied observationally. In this study, we present that ellipticity of bulges showing non-axisymmetry and nuclear starbursts have a correlation with using SDSS DR7. This relation is dependent on the Hubble type and environmental factors.

2. Sample selection and data analysis

Firstly, we used volume limited r-band late-type galaxies from SDSS DR7 ranged in $M_r < -19.5$, $0.02 <= z <= 0.05489$ and axis ratio $b/a > 0.6$ for elongated bulges on the view of face-on disks, and only selected galaxies with no warning flag in their spectrum (zwaring=0, sciencePrimary=1). Then we separated the sample to the nuclear non-starburst and starburst galaxies located in the star-forming region of the BPT diagram with an equivalent width of Hα greater than 50 Å (Abazajian *et al.* 2009, Choi *et al.* 2010). Secondly, we matched the sample to the catalog of the bulge/disk decompositions

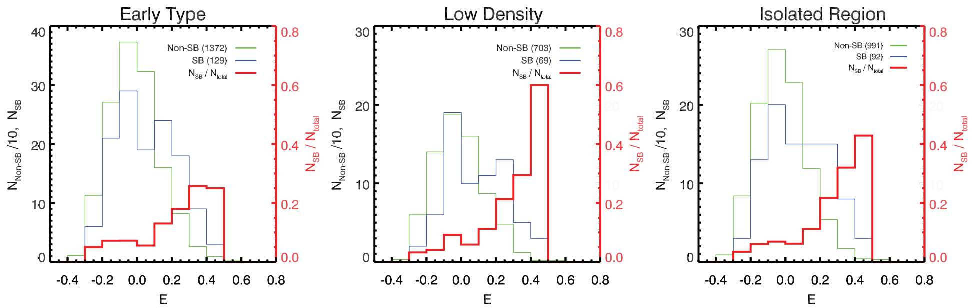

Figure 1. Distribution of nuclear star forming and non-star forming galaxies on the E in galaxies with 0.15<B/T<=0.41. Green lines show the number of non-starburst galaxies divided by 10, the red lines indicate the number of nuclear starburst galaxies, and the blue lines show the fraction of Non-SB/ SB galaxies of each ellipticity bin on right vertical axis. Left to right sample is early type disk galaxies, those in a low density and isolated region. [A color version is available online.]

from the Legacy area of SDSS DR7 (Simard *et al.* 2011) providing a bulge semi-major axis effective radius of bulge and bulge fraction (B/T), etc. The sum of an exponential disk and a de Vaucouleurs bulge (Sersic index n=4) was used as a galaxy image model, and we excluded the sample with a bad fitting probability ($P_{pS} > 0.32$) and an effective radius lower than 1 pixel. Third, environmental factors of galaxies from Park & Choi (2008), which are mass density of twenty closest galaxies (ρ_{20}/ρ_{ave}) and a separation between the target and the closest galaxy ($r_p/r_{nei,vir}$) were adopted for the final set. We used a IRAF/ELLIPSE task to derive the bugle component ellipticity for the final sample. Finally we have 3173 galaxies including 2923 non-starburst, 250 nuclear starburst galaxies. Here we use E that indicates disk ellipticity subtracted from bulge ellipticity in order to consider disk inclination.

3. Results

We find a moderate, but clear correlation between the nuclear star formation and non-axisymmetric shape of bulges (Figure 1). Specifically, this relation intensifies in the galaxies with a high bulge fraction ($0.15 < B/T <= 0.41$) corresponding to the early type compared to the low bulge fraction galaxies. In galaxies with a clear bulge, the relation sustains; however, it weakens in the galaxies with a prominent disk. Also, galaxies in low density environments have a higher fraction of starbursts as ellipticity increases compared to the high density galaxies. This suggests that the relation is maintained in the low density region ($\rho_{20}/\rho_{ave} < 5$), but the external factors disintegrate the relation in a group or a cluster environment ($\rho_{20}/\rho_{ave} > 5$). Even on the point of view of the small-scale environment, the dependence grows in isolated galaxies ($r_p > r_{nei,vir}$), but it drops in interacting galaxies ($r_p < r_{nei,vir}$). In this case, flying by or merging neighboring galaxies could reduce the dependency. In summary, our results show statistically that nuclear starbursts have a dependency on the elongated bulges with a large number of observation data. This relationship is clear in early type galaxies and those in low density and isolated region.

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