Evolution of Galaxies with Episodic Star Formation at $0.2<z<0.8$ in COSMOS

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Abstract

Using the COSMOS intermediate-band data set taken with Suprime-Cam, we investigated galaxies with episodic star formation at $0.2<z<0.8$. We constructed the pseudo rest-frame UBV-bands two-color diagram for galaxies with $M_V < -20$ at $0.2<z<0.8$, and measured color offsets from a sequence of the continuous star formation models to search for galaxies with episodic star formation, namely, old population + recent burst of star formation or post-starburst galaxies. We found that the dispersion of the color offsets increases with redshift, which suggests that the fraction of galaxies with episodic star formation decreases with time from $z=0.8$ to $z=0.2$. At $z>0.6$, fainter galaxies tend to have the higher fraction of these galaxies. We also examined the morphology of these galaxies with the HST/ACS images, and found that “old + burst” galaxies tend to show irregular/interacting morphology, while continuously star-forming galaxies tend to be normal spiral galaxies.

Introduction

Many studies have studied the cosmic star formation rate (SFR) density as a function of redshift, and found that the SFR density decreased by about an order of magnitude from $z=1$ to $z=0$. But the detailed star formation history at $z < 1$ of individual galaxy samples the Balmer/4000Å break, and so on. In this study, we construct the rest-frame UBV-band 2-color diagram at various redshifts over $0.2<z<0.8$ in order to study continuous star formation histories of galaxies in a short timescale.

Data & Analysis

- COSMOS survey data
  - Intermediate-bands photometry
  - COSMOS photometric catalog (Capak+07)
  - Redshifts $\& M_{15}$ photo-z with 35-bands data (Ilbert+09)
  - Effective survey area is $\sim 1.7$ deg
  - Sample galaxies with $M_V < -20$ at $0.2<z<0.8$ in order to study star formation histories of galaxies in a short timescale.

- 2-color diagram & redshift bins
  - We directly observed the intermediate bands photometry to construct 2-color diagram (no K-correction).
  - We chose the redshift ranges so that the IBs of the IA bands sample the rest-frame at 4000Å, 4200Å, and 5200Å.
    - The effects by the strong emission lines can be avoided.
    - The effect of the offset(redshift/error) on the rest-frame color is small (Figure 1a).

- Color offset from the sequence of continuous star formation
  - As shown in Figure 1, the models of continuous star formation (CSF) form a sequence in the 2-color diagram.
  - We used a color offset from the sequence of CSF in $m_{4200}$-5200 color as a signature of episodic star formation.
  - We excluded the following analyses galaxies redder than the $t=10$yr model at $50\sigma$ old and those bluer than the $t=10$yr model at $50\sigma$ old in $m_{4200}$-5200 color (vertical lines).
  - We fitted the color track of the $t=10$yr model between age=10yr and $50\sigma$ with a straight line, and use it as the sequence of CSF (the reference for the color offset).

- Color offsets from a sequence of continuous SF
  - The effect of the redshift offset/error on the rest-frame color is small (Figure 1a).
  - We calculated the dispersion of the color offset in each redshift bin, while blue histogram shows that of galaxies at $z=0$, convolved with the mean photometric error of galaxies in each bin.
  - The dispersion of the color offset is wider at $z=0$ even if the photometric error is taken into account.

- Evolution of the fraction of galaxies with episodic star formation
  - We divided galaxies with episodic SF into two populations, namely, old + recent burst population and post-starburst one in the 2-color diagram.
  - Bluer than the constant SFR model in $m_{5200}$-5200 color
  - $\bullet$ old + burst
  - $0.05-0.5$ Gyr after the star formation stopped
  - post-starburst
  - We investigated the fraction of the old-burst and post-starburst populations as a function of redshift separately.

- Fraction of old-burst/post-starburst galaxies as a function of redshift. The error bars include the effect of a possible photometric error offset of 0.03 mag. Open circles show the results when the color criterion is shifted by the mean $1\sigma$ photometric error.

Old + recent burst & Post-starburst populations

- Fraction of old-burst/post-starburst galaxies as a function of redshift. The error bars include the effect of a possible photometric error offset of 0.03 mag. Open circles show the results when the color criterion is shifted by the mean $1\sigma$ photometric error.

- The fraction increases with redshift for all the magnitude ranges.
- The photometric error does not significantly affect the results.
- At $z > 0.6$, fainter galaxies show a larger dispersion.
- Episodic star formation occurs more frequently in faint galaxies?
- SES of fainter galaxies are more easily affected by such a burst of star formation?

- morphology
  - HST/ACS $i_{rest}$-band images for galaxies at $z>0.6$
  - old + recent burst
  - continuous SF
  - post-starburst

- Larger fraction of irregular/peculiar or multiple morphology.
- Continuous SF galaxies tend to be normal spirals.

- Earlier morphology than continuous SF.
  - Stepping SF, morphological redshift transition are succeeded.
  - Edge-on disks, dusty contaminants?