Low-mass passive and post-starburst galaxies at $z = 1.5 - 2.0$ in the UltraVISTA field

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Introduction

Investigating how star formation stopped is important to understand star formation history of galaxies.

The fraction of passive galaxies depends on both stellar mass & environment.

- Mass quenching
- Environmental quenching

Peng+10

Local galaxy density

log $M [M_\odot]$ mass

Peng+10 at $z \sim 0$
We investigated the low-mass end of the stellar mass function of passive and post-starburst galaxies at $z \sim 2.0$. 

The mass function of passive galaxies at high redshift

$z \sim 1 - 2$

Strong number density evolution of massive passive galaxies

How about low-mass of passive galaxies?

Post-starburst galaxies are also important
Data

- UltraVISTA DR2 ultra-deep stripes (Y J H Ks - band data)
  0.73 square degree in the COSMOS field
- Subaru/SCam ultra-deep imaging (z - band data)
  Picking up the Balmer/4000Å break of the galaxy at z \approx 2

- Limiting magnitude
  \[ z = 26.8, \ Y = 25.8, \ J = 25.3, \ H = 25.0, \ Ks = 25.1 \]
  AB magnitude (5σ, 1.8” aperture)

- 0.40 square degree
  (overlaps with these data)
Analysis

1. Source detection on the Ks-band image

2. Color selection for passive & post-starburst galaxies at $z = 1.5 - 2.0$ with $z-J$ v.s. $J-K$ diagram

3. Removing contaminants with photo-z using $U, B, r, i, IA484, IA624, IA738, z, Y, J, H, Ks$ bands (only high-quality data with $<0.9”$ PSF FWHM)

4. Estimate $M_V$ and stellar mass from the SED fitting

5. Calculate completeness for the color selection as a function of $M_V$

6. Derive stellar mass function of passive & post-starburst galaxies at $z \sim 2$ with the $1/V_{\text{max}}$ method
Selection for passive & post-starburst galaxies at $z = 1.5 - 2.0$

Color selection

- Post starburst galaxies at $z = 1.5 - 2.0$
- Passive galaxies at $z = 1.5 - 2.0$
- Other galaxies
- Star forming
- Av=1 mag of Calzetti’s law

Single 0.5Gyr burst model:

- Age = 3Gyr
- 2Gyr
- 1Gyr
- 0.1Gyr

dots represent galaxies at $z = 1.5, 1.6, 1.7, 1.8, 1.9, 2.0$
Photometric redshift distribution

Passive galaxies
at $z_{\text{phot}} = 1.4 - 2.15$

Post-starburst galaxies
at $z_{\text{phot}} = 1.5 - 2.05$

passive galaxies
728 samples

post-starburst galaxies
303 samples
Process of finding the completeness

1. Assuming SEDs of galaxies with each V-band absolute magnitude using single 0.5 Gyr burst models with ages of 1, 2 and 3 Gyr.

2. For these model SEDs at each redshift, we calculated the apparent magnitudes used in the color selection.
   - Carried out Monte Carlo simulation adding the random photometric errors to the calculated apparent magnitudes.
   - Performing the same color selection again.

3. We can estimate the completeness from the fraction of simulated objects which satisfy the selection criteria.
The number density of low-mass passive galaxies is relatively small.
Stellar Mass Function of post-starburst galaxies \((at \ z = 1.5 - 2.05)\)

Parameters of Schechter function:

\[
\Phi^* = 0.90 \pm 0.17 \times 10^{-4} \, [\text{Mpc}^{-3}]
\]

\[
M^* = 6.70 \pm 2.04 \times 10^{10} \, [M_\odot]
\]

\[
\alpha = -0.68 \pm 0.14
\]

Post-starburst galaxies show flatter low-mass end slope.
Discussion

The low-mass end slopes are significantly different between passive and post-starburst galaxies.

Post-starburst galaxies dominate in number at low stellar mass.

Since post-starburst galaxies evolve into passive galaxies within \( \sim 1 \) Gyr, these galaxies are expected to cause stronger evolution of the number density of the passive population at lower mass.
Mass & environmental quenching

- The number density of passive galaxies at $z = 1.4 - 2.15$ decreases with decreasing stellar mass.
  - $\text{mass quenching has dominated by } z \sim 2$ ?

- Low-mass post-starburst galaxies show a similar number density with massive ones.
  - $\text{environmental quenching may start to work}$ ?
Future work

- Derive the stellar mass function of post-starburst galaxies at various redshifts and investigate the evolution of its shape and normalization.

- Investigate the environments of these post-starburst galaxies and its evolution.
Summary

- We investigated the stellar mass function of passive galaxies at $z = 1.4 - 2.15$ and post-starburst galaxies at $z = 1.5 - 2.05$ down to $10^{10} \, M_\odot$, using the ultra-deep Scam z-band and UltraVISTA DR2 data.

- We found that the number density for low-mass passive galaxies is smaller than massive galaxies.

- On the other hand, post-starburst galaxies show a significantly flatter low-mass end slope.

- If these post-starburst galaxies become passive galaxies, the number density of low-mass passive galaxies is expected to increase more rapidly than high-mass ones.