Progenitor Study of Milky-Way-Like Galaxies over the Cosmic High Noon (arXiv:1502.05713)

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This poster is available here.

Summary: We make use of the recent released *HST*/WFC3 IR and ACS imaging data by CANDELS and 3D-HST. Based on the constant number density method, we sample the progenitors of Milky Way-like galaxies (MWs) and massive galaxies (MGs) from z~3 to 0.5. After stacking 1D radial profiles we conduct the "radially-resolved SED fit". By using the spatial distributions of the SED parameters (stellar mass and rest-frame UVJ colors), we investigate the mass assembly history of MWs and MGs over the redshift range. We find that MWs obtain their stellar mass in a self-similar way at 1<z<3, while MGs in "inside-out" way with rapid bulge growth at z>2 and obtain the outer mass at z<2. The mass growth of MWs' bulge at z<1, even after its quenching, is worth being investigated. A new approach to the morphological variety finally probes the "dichotomy" of galaxies.

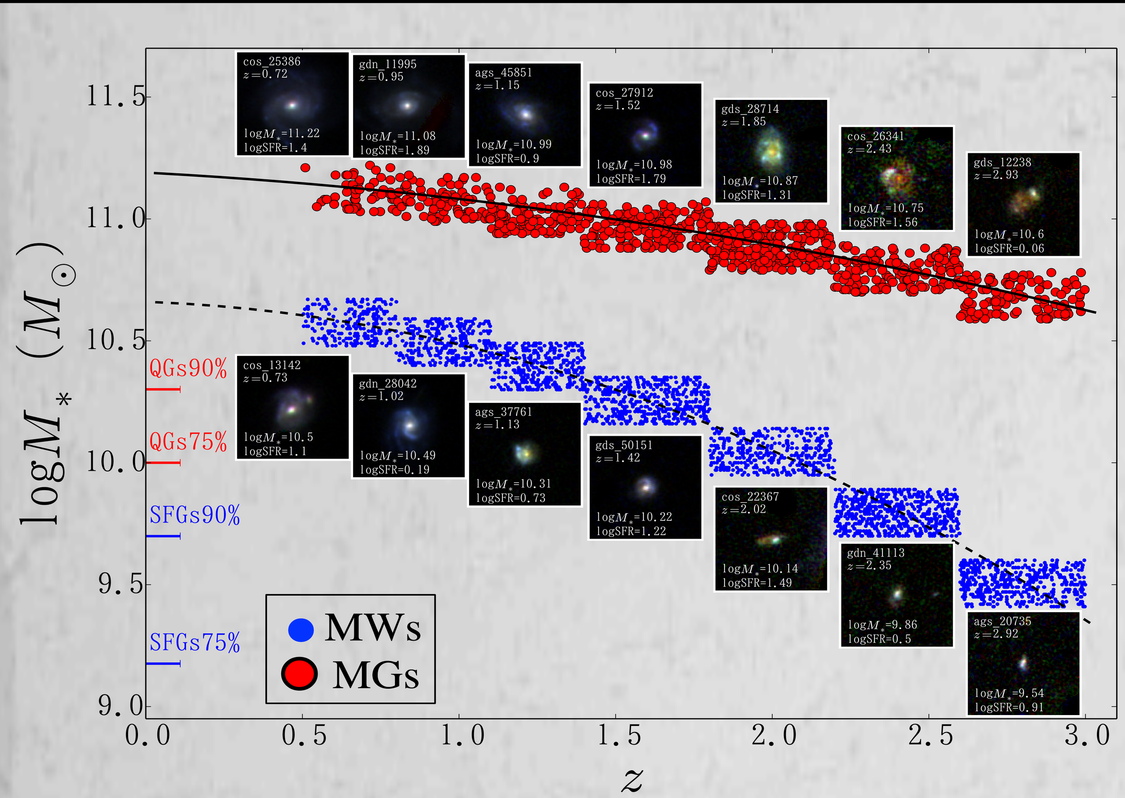


Figure 1 : MW (blue) and massive galaxy progenitors (red).

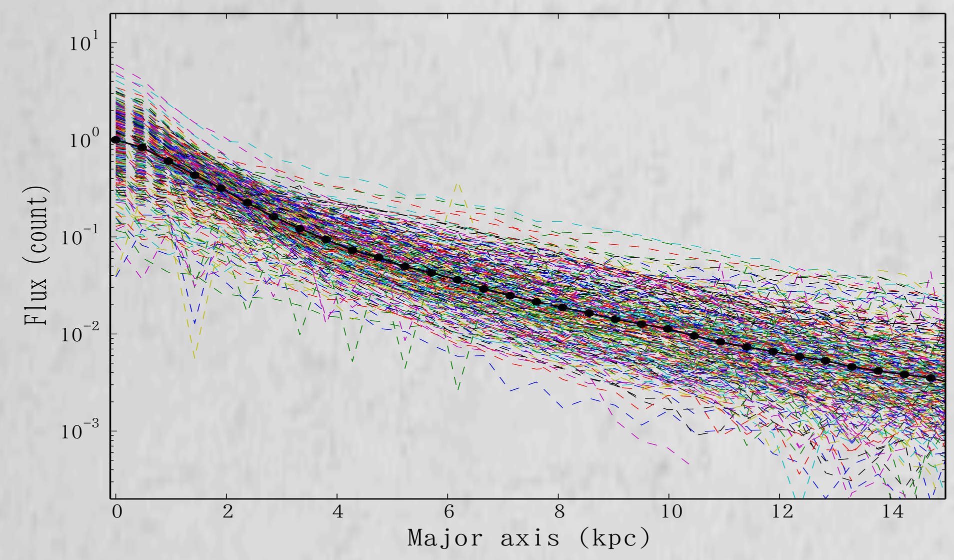


Figure 2 : Example of median (thick black) and all the profiles that enter the median (colored lines). The dispersion at each radius is "the morphological variety".

2.Data (Fig.1)

2.1. CANDELS / 3D-HST multi-wavelength imaging data (ACS/WFC3; Skelton+14)

2.2. Extracting the progenitors at 0.5<z<3.0; with constant number densities, $\log(M_{\rm MW}) = 10.7 - 0.045z - 0.13z^2$ for MWs and $\log(M_{\rm MG}) = 11.2 - 0.068z - 0.04z^2$ for MGs.

3.Analysis (Fig.3)

3.1. Stacking Analysis of 1D Radial Profiles

As faint galaxies are buried in noise, even with *HST*'s very deep survey, some galaxies do not have sufficient S/N per each pixel. To conduct the robust SED fit and derive radial mass profiles, we stack the samples in each redshift bins in each filter band, with extreme care (e.g., neighbor masking, sky subtraction, *K*-correction).

3.2 Radially Resolved SED fitting

We derive SEDs by using FAST code (Kriek+09) for all radial pixels with S/N>3. The criteria of S/N is set by the Monte Carlo simulation, where we verified stellar mass above $10^7 M_\odot$ is robustly derived.

3.3. Morphological Variety

In addition, we estimate the variety in morphology at each redshift bin. We compare the median and each radial profile that enter the stacking (Fig.2), and estimate the variety with,

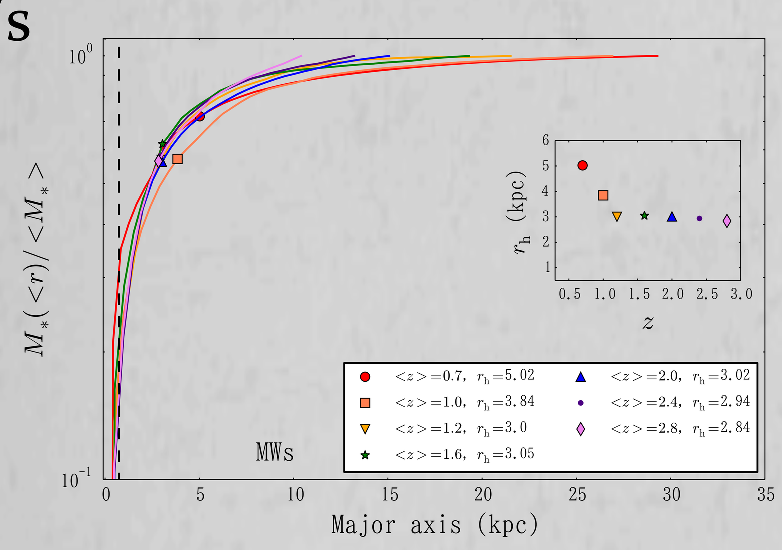
$$\Delta_{{\rm norm},x} = \frac{1}{S_x}\sum_i^x \left|\frac{f_{i,{\rm median}} - f_{i,{\rm obs}}}{f_{i,{\rm median}}}\right|,$$

where we set x < 2.5 kpc and 2.5 < x < 10 kpc in the following to see the radial dependence of the variety. S_x is the total pixel within the range of x.

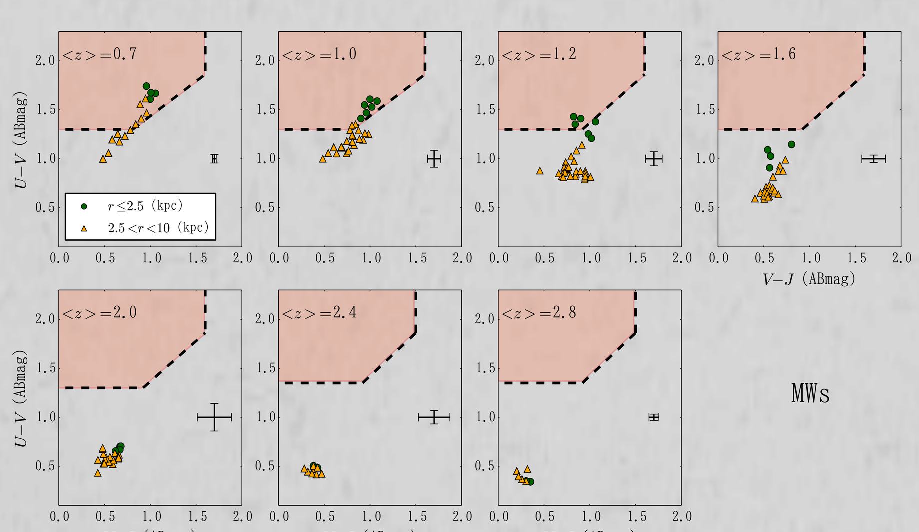
4.Results

Stellar Mass Profiles | **UVJ Colors** | **Morphological Variety**

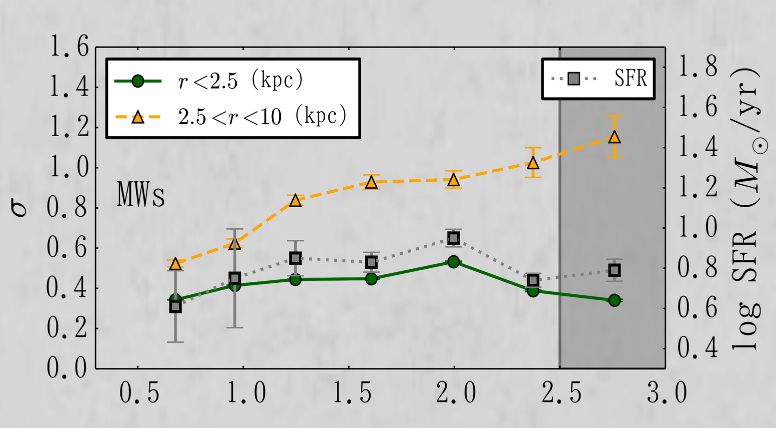
MWs



"Self-similar"

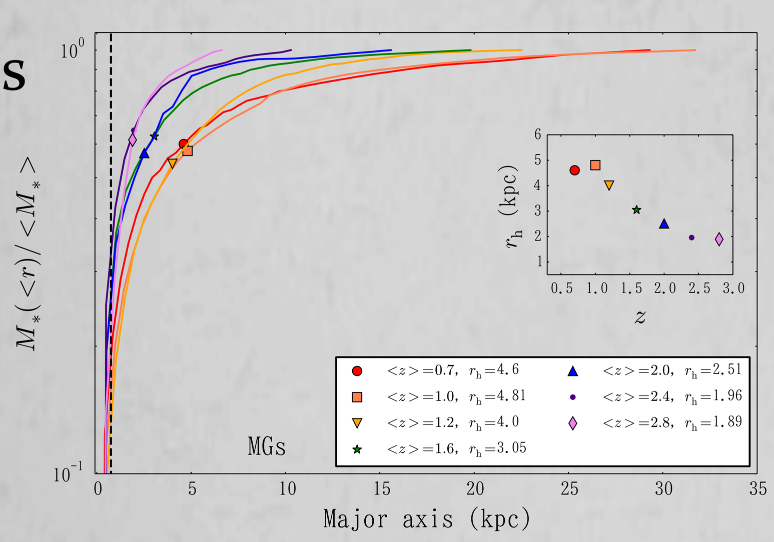


"Inside-out"

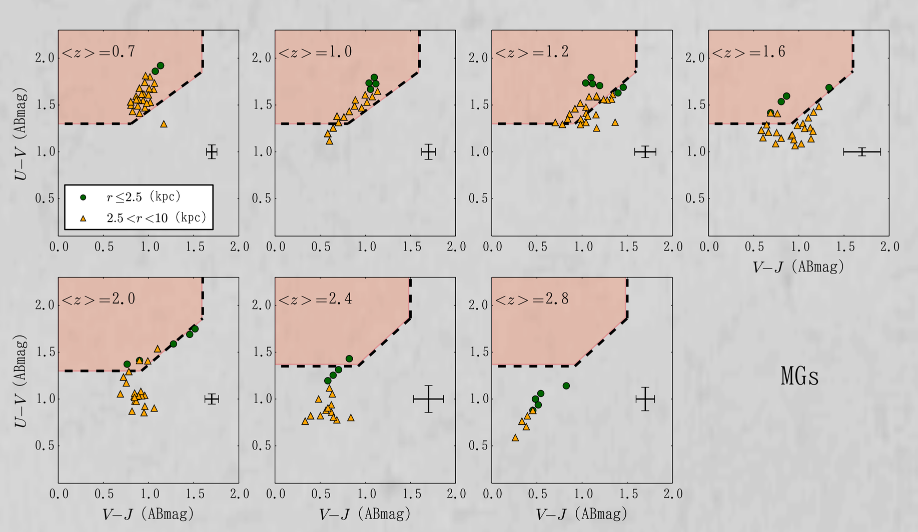


Inner bulge has less variety. Outer disk show varieties.

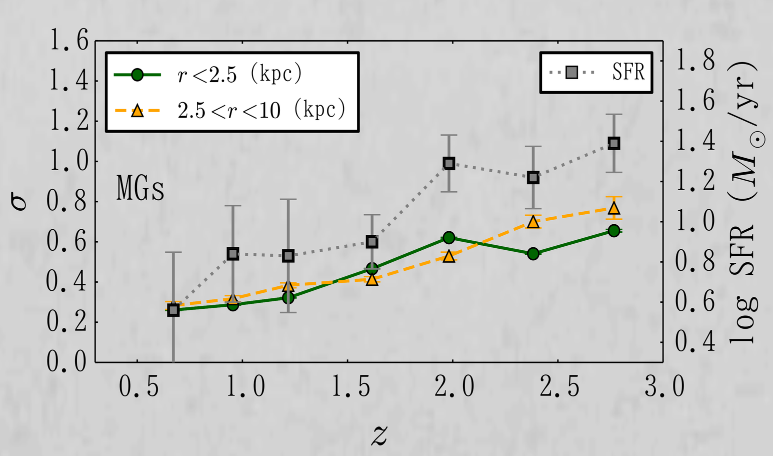
MGs



"Inside-out"



"Inside-out"



"Rapidly" converge to a similar morphology, at the all radii.

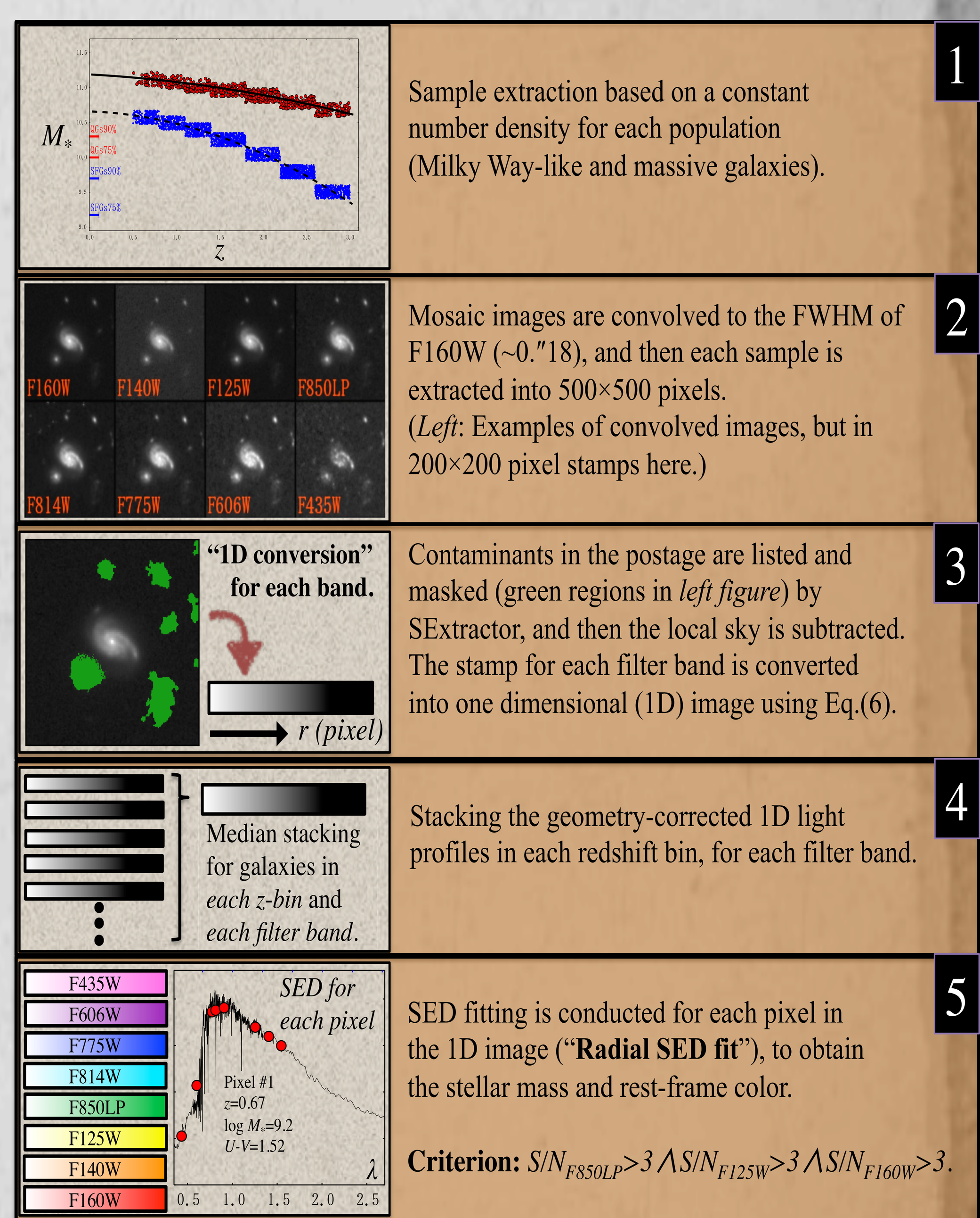


Figure 3 : Schematic view of our analysis method.

5.Discussion

–How did the progenitors obtain stellar mass over the Cosmic Time?–

The stellar mass of MWs increases in "self-similar" way, irrespective of the radial distance, while that of MGs grows in "inside-out" way where they obtain ~ 75% of the total mass at outer (> 2.5 kpc) radius since z ~ 2.

Although the radial mass profiles evolve in distinct ways, the formation and quenching of the central dense region (or bulge) ahead of the outer disk formation are found to be common for both systems.

The morphological variety of the radial mass profiles for MGs peaks at higher redshift (z > 2.8), and then rapidly decreases at z < 1.5 (toward an uniform profile), while that for MWs remains in the outer region over the redshift. Compared with the observed star formation rates and color profiles, the evolution of variety is consistently explained by the star formation activities.