BRIDGING BETWEEN THE INTEGRATED AND RESOLVED MAIN SEQUENCE OF STAR FORMATION

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ABSTRACT

The position of galaxies on the stellar mass, star formation rate plane with respect to the star-forming main sequence at each redshift is a convenient way to infer where the galaxy is in its evolution compared to the rest of the population. We use Hubble Space Telescope high resolution images in the GOODS-S field from the CANDELS survey and fit multi wavelength lights in resolution elements of galaxies with stellar population synthesis models. We then construct resolved kpc-scale stellar mass, star formation rate surface density curves for galaxies at $z \sim 1$. Fitting these resolved main sequence curves with Schechter functions we parameterize and explain the multi-wavelength structure of galaxies with three variables: ϕ^*, α, and M^*. For quenched galaxies below the main sequence, we find an average high mass slope (α) of the resolved main sequence curves to be ~ -0.4. The scatter of this slope is higher among the lower mass star forming galaxies and those above the main sequence compared to quenched galaxies, due to lack of an evolved bulge. Our findings agree well with an inside-out quenching of star-formation. We find that the knee of the Schechter fits (M^*) for galaxies below the main sequence occurs at lower stellar mass surface densities compared to star forming galaxies, which hints at how far quenching has proceeded outwards.

Figure 1. Left:Galaxies selected for this study are shown as red circles on top of all GOODS-S galaxies at $z \sim 1$ shown with cyan dots. Black dashed line shows the main sequence of star forming galaxies at this redshift from Noeske et al. (2007). Right: HST cutouts in F435W, F775W, and F160W of a star forming and quenched galaxy on top and bottom panels, respectively.

↑Fig1. Ms vs. SFR (sample definition)

Resolved MS分布のSchechter Fitによる定量化

- Ms vs. SFR図においてMSに対してどこに位置するかは銀河進化段階を知る有効な手段。
- 各銀河についてΣMs vs. ΣSFR分布をSchechter fitし、そのパラメタを比較。
- MSより下 (上) にいる銀河はSchechter slope (α) が小さい (大きい)。
  → 中心部の星形成が静穏 (活発) → evolved bulgeがある (作っている)
  → inside-out quenchingと解釈。

↓Fig2. ΣMs vs. ΣSFR とSchechter Fit例

各銀河のresolved MS分布を
Schechter関数で定量化

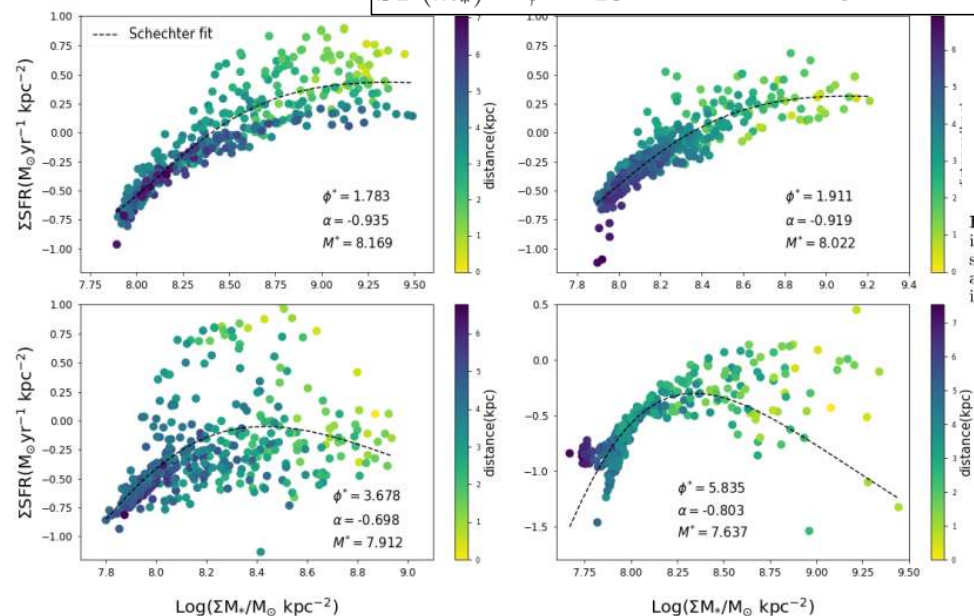$$SF(m_*) = \phi^* \times 10^{(M^*-m_*)(\alpha+1)} \times e^{-10^{(M^*-m_*)}}$$

Figure 2. Resolved star formation surface density vs. stellar mass surface density plots of four sample galaxies color coded by distance from the center. Dashed black lines show the best Schechter function fit to data.
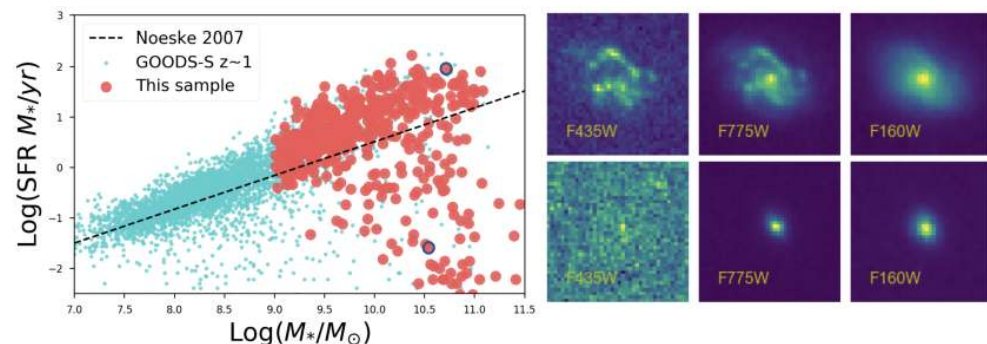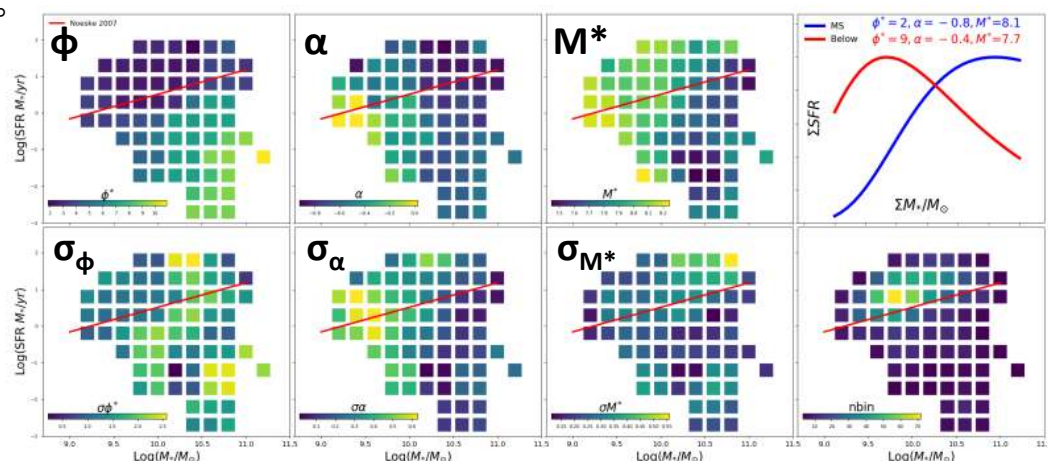

Figure 3. Schechter parameters best fitted to the resolved main sequence of star formation of individual galaxies are shown on the binned integrated stellar mass-SFR plane. Left-three columns show the median (top) and standard deviation (bottom) of ϕ^*, α, and M^*. Red solid line shows the main sequence of star-forming galaxies at $z \sim 1$ to guide the eye. Top-right panel shows two Schechter functions with average value of galaxies on and two dex below the main sequence at $Log(M_*/M_\odot) \sim 10.5$. Bottom-right panel shows number of galaxies in each bin of SFR and stellar mass.

↑Fig3. Ms vs. SFR 上でのSchechter Parameters分布

- α: high ΣMs end slope＝銀河中心spaxelの星形成を反映。
  - α小＝中心で活発、α大＝外側で活発
- σ_α: とあるMs・SFR binの銀河のα (星形成モード)のばらつき。
  - σ_α小＝ほぼ同じモード、σ_α大＝様々なモードが混在
- MS上ではHigh Msほどσ_α小 → evolved bulgeを示唆 (low Msでは形成途中)。
  → 星形成のinside-out quenchingと解釈。
- Above MSではσ_α大 → 星形成clumpの存在が影響か。