WHERE STARS FORM: INSIDE-OUT GROWTH AND COHERENT STAR FORMATION FROM HST Hα MAPS OF 2676 GALAXIES ACROSS THE MAIN SEQUENCE AT $Z \sim 1$

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ABSTRACT

We present Hα maps at 1 kpc spatial resolution for star-forming galaxies at $z \sim 1$, made possible by the WFC3 grism on HST. Employing this capability over all five 3D-HST/CANDELS fields provides a sample of 2676 galaxies enabling a division into subsamples based on stellar mass and star formation rate. By creating deep stacked Hα images, we reach surface brightness limits of 1×10^{-18} erg s^{-1} cm^{-2} arcsec^{-2}, allowing us to map the distribution of ionized gas out to greater than 10 kpc for typical L* galaxies at this epoch. We find that the spatial extent of the Hα distribution increases with stellar mass as $r_{H\alpha} = 1.5(M_*/10^{10}M_\odot)^{0.23}$ kpc. Furthermore, the Hα emission is more extended than the stellar continuum emission, consistent with inside-out assembly of galactic disks. This effect, however, is mass dependent with $r_{H\alpha}/r_* = 1.1(M_*/10^{10}M_\odot)^{0.054}$, such that at low masses $r_{H\alpha} \sim r_*$. We map the Hα distribution as a function of SFR(IR+UV) and find evidence for 'coherent star formation' across the SFR-M_* plane: above the main sequence, Hα is enhanced at all radii; below the main sequence, Hα is depressed at all radii. This suggests that at all masses the physical processes driving the enhancement or suppression of star formation act throughout the disks of galaxies. It also confirms that the scatter in the star forming main sequence is real and caused by variations in the star formation rate at fixed mass. At high masses ($10^{10.5} < M_*/M_\odot < 10^{11}$), above the main sequence, Hα is particularly enhanced in the center, indicating that gas is being funneled to the central regions of these galaxies to build bulges and/or supermassive black holes. Below the main sequence, the star forming disks are more compact and a strong central dip in the EW(Hα), and the inferred specific star formation rate, appears. Importantly though, across the entirety of the SFR-M_* plane we probe, the absolute star formation rate as traced by Hα is always centrally peaked, even in galaxies below the main sequence.

Subject headings: galaxies: evolution — galaxies: formation — galaxies: high-redshift — galaxies: structure — galaxies: star formation

何処で星を作り、銀河の構造を形成するのか？

- ❑ HST/WFC3 G141 slitless 分光 (R~130)
- ❑ z~0.7-1.5 star-forming galaxies 2676天体
- ❑ UVJ selection → Hα輝線強度 selection
  - ❑ 連続光のpeakで合わせて画像を stacking → high-S/N 2D map
  - ❑ Clumpy SF は消えてしまうが、disk に広がる平均的な SF を見る
- ❑ SED fitting → M_s, SFR(UV+IR) 算出 → star-forming main sequence

- どのM_s, SFRでも、中心ほど星も星形成も密度が高い (ほぼ exp 的)
- MS より上の、より活発な銀河は disk 全体で SFR 高い (逆も然り)
  → 銀河の規模によらない coherent な星形成メカニズムがある？
- High-mass ほど、銀河中心部でHαが強い
  → bulge or SMBH 形成中？
- EWは flat or centrally depressed 気味
  → 星形成の方が広がっている → inside-out 的成長を示唆

z~1 星形成銀河はその星質量によらず、disk 上で inside-out 的に星が形成・蓄積されているようだ。

Fig.3: 連続光とHα輝線の resolved map 例

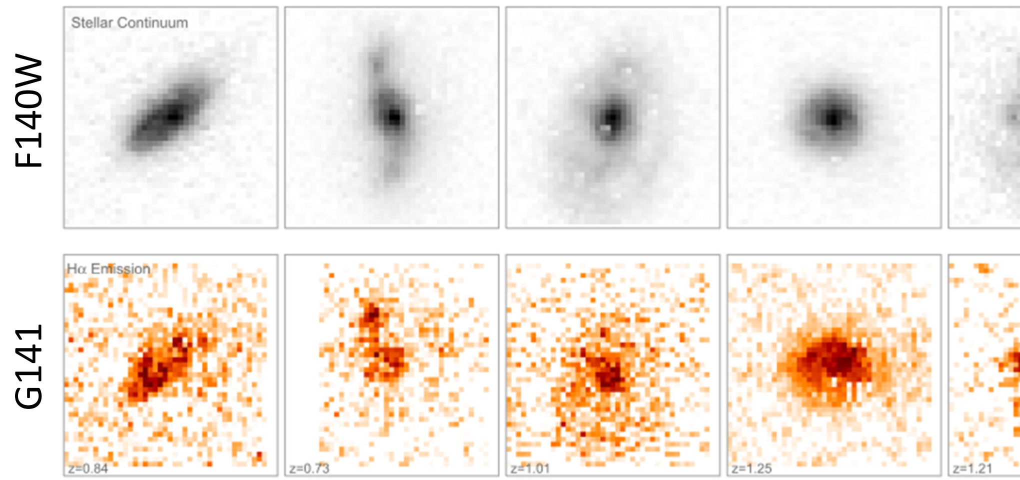

FIG. 3.— High resolution Hα maps for $z \sim 1$ galaxies from HST and their corresponding rest-frame optical images. The Hα generally f
but not always (see also Wuyts et al. 2013).

Fig.9: Hα輝線と連続光の radial profile (from stacked 2D map)

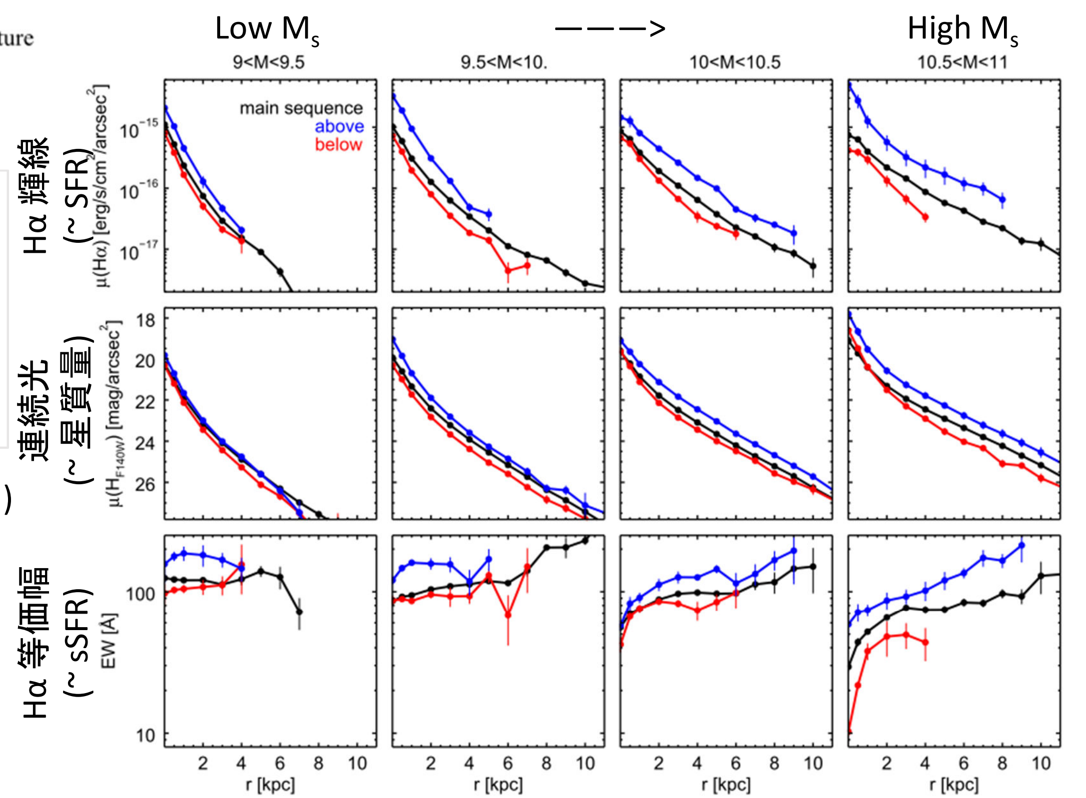

FIG. 9.— Radial surface brightness profiles of Hα, H_{F140W}, and their ratio EW(Hα) as a function of M_* and SFR. The colors delineate position with respect to the star forming 'main sequence': above (blue), on (black), and below (red). Above the star forming main sequence, the Hα (as well as the H_{F140W} and EW(Hα)) is elevated at all radii. Below the star forming main sequence, the Hα is depressed at all radii. The average radial profiles are always centrally peaked in Hα and never centrally peaked in EW(Hα).