FRESCO: The Paschen-α Star Forming Sequence at Cosmic Noon

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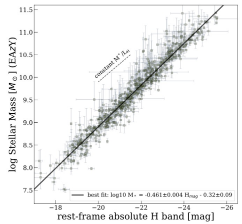
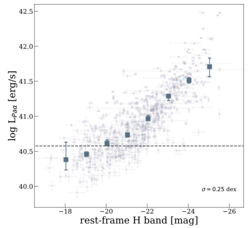
1.Introduction

・SFS(star forming sequence) of galaxies = relation SFR−M*
　→how galaxies build up their mass and quench at cosmic noon
　・tight relation (scatter～0.2−0.3 dex ($M* = 10^{9-10}$ Msun))
　↔conflicting results (higher scatter at low mass end or high mass)
　　・due to using the different method to infer SFS and select galaxies
　　　→methods to infer SFR and M* affect the measured SFS
　⇨the true relation and the best method

2.Data

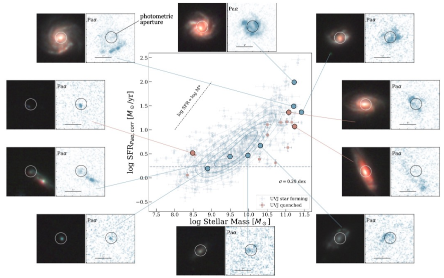
・FRESCO survey (the First Reionization Epoch Spectroscopically Complete Observations survey, Oesch et al. 2023)
　→F444W NIRCam/grism spectra & imaging data in the GOODS fields
・sample selection (z～1−2)
　・robust fit with a single line and consistent morphological shape between the line and imaging (F444W), or robust fit with multiple lines
　・Paα S/N > 5 and 95% confidence width (z_width) < 0.005
　→609 galaxies
・EAzY SED fitting : one of the simplest SED fitting methods
　→the flux corrected 0.7" diameter aperture photometry
　→physical properties(rest-frame colors, M*)

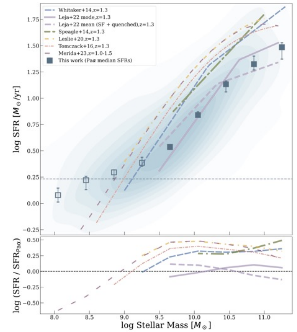




4. DISCUSSION

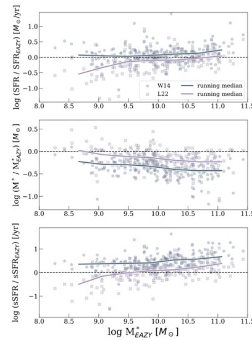
・a tight relation between SFR−M*
　→most galaxies have similar SF processes
　　↔scatter > the relation between Paα luminosity and rest-frame H band magnitude
　　　・due to the assumptions in the conversions to SFR and stellar mass
・compare data with previous studies
　・most studies : a steeper relation at lower and a flattening at high masses
　　↔a shallower slope at lower masses and a steeper slope at higher masses
　・ the differences between previous relations and median SFR data points
　　・M > 9.5M☉→offset from studies for ～0.6 dex lower
　　・the least offset : Leja et al. 2022
・isolate uncertainties associated with M* and SFR at different methods for the same sources
　・Leja et al. (2022) : measure SFRs and masses from PROSPECTOR SED fitting
　・Whitaker et al. (2014) : measure SFRs from UV+IR and masses from FAST SED fitting
　・SFR→consistent with both Whitaker et al. (2014) and Leja et al. (2022) (mean differences～0.1 dex)
　　・larger deviation in the differences with Leja et al. (2022) at the low mass end
　　　・previous studies→increase scatter between different SFR indicators at the lower end of the SFR distribution
　・M*→consistent with the Leja et al. (2022)
　　・consistently measure higher masses than Whitaker et al. (2014) by ~0.2−0.4 dex
　⇨inferred stellar masses contribute to the offset in the SFS with many previous studies
　・sSFR → consistent with Leja et al. (2022), offset from Whitaker et al. (2014) due to the offset in stellar mass
・separate the SF and quenched galaxies by the UVJ diagram
　・the locations of quenched galaxies along the SFS
　　→most of the quenched galaxies fall within the high mass, low sSFR regime (not enough data)
　　・may be important for larger surveys when using UVJ selection criteria
・most of the SF galaxies : SF is concentrated in the central regions
　↔some of the quenched galaxies : SF is occurring on the outskirts and is missed with the 0.7" circular apertures used in the photometric measurements
　→Further explorations of color gradients and photometric aperture sizes are needed





3. DERIVING THE STAR FORMING SEQUENCE

・distinction between quenched and star forming galaxies by UVJ diagram
　・U−V>1.3, V−J<1.5, U−V>0.88(V−J)+0.59
　⇨13 galaxies : quenched despite having significant Paα emission lines
・the tight correlation between M* and rest-frame H band magnitude
　・M* are derived from SED fitting that incorporates the rest-frame NIR bands
　・completeness limits = the detection limits for compact sources
　・$\log(M*)[M_\odot] = (-0.461 \pm 0.004)H_{mag} - (0.32 \pm 0.09)$
　　・H_{mag} : absolute magnitude at rest-frame 1.6um
　　・the 5σ detection limit (2×10^{-18}erg/s) of the grism spectra at the highest redshift (z = 1.68)
　　→ the completeness limit at $L_{Pa\alpha} = 10^{40.57}$erg/s
・the dust-corrected SFR vs M*
　・$SFR_{Pa\alpha,corr}[M_\odot/yr] = 4.6\times10^{-41}\ L_{Pa\alpha,corr}$[erg s−1] ($L_{Pa\alpha,corr}$: the dust-corrected Paα luminosity)
　　・SFR completeness limit : $SFR_{Pa\alpha,corr}$ = 1.7 M☉/yr
　・color data points : star forming or quenched
　・spatially resolved Paα emission line maps (by grism spectra)
　　→where star formation is occurring
　・uncertainties
　　・grism spectroscopy → SFR from Paα emission lines
　　・SED fitting→M*



5. CONCLUSION

・use Paα as relatively dust-insensitive tracer of SFR at cosmic noon, incorporate rest-frame NIR photometry to derive M*
→ a direct, independent measurement of SFS of galaxies at z ~ 1 − 2
・low scatter in the directly observed relation between the rest-frame H band magnitude and uncorrected Paα luminosity
・At 10^{10-11} M☉ , relation is offset from other studies
　・good agreement with results obtained using the PROSPECTOR fitting framework (Leja et al. 2022)
・quenched galaxies defined by UVJ have spatially resolved emission line maps obtained from grism spectroscopic data
　→probe exactly where star formation is occurring in these galaxies
・more data from JWST→this method will be able to expand understanding of the SFR−M* relation through simpler, independent measurements of SFR and M*at cosmic noon
　・the process of quenching can be further explored by Paα emission using emission line maps produced by grism spectroscopy
　・this methods can be applied to larger samples to measure the SFS in this redshift regime and constrain the low mass end