Galaxy & AGN evolution SWG

WP5

Passive galaxies

Michele Moresco & Chris Lovell

Wiki page: https://euclid.roe.ac.uk/projects/geswg/wiki/Passive_galaxies
Members & Mailing list: Currently 52 members, internal mailing list (email us).
Telecon: Monthly (see https://euclid.roe.ac.uk/projects/geswg/wiki/Passive_galaxies#Telecon-notes).

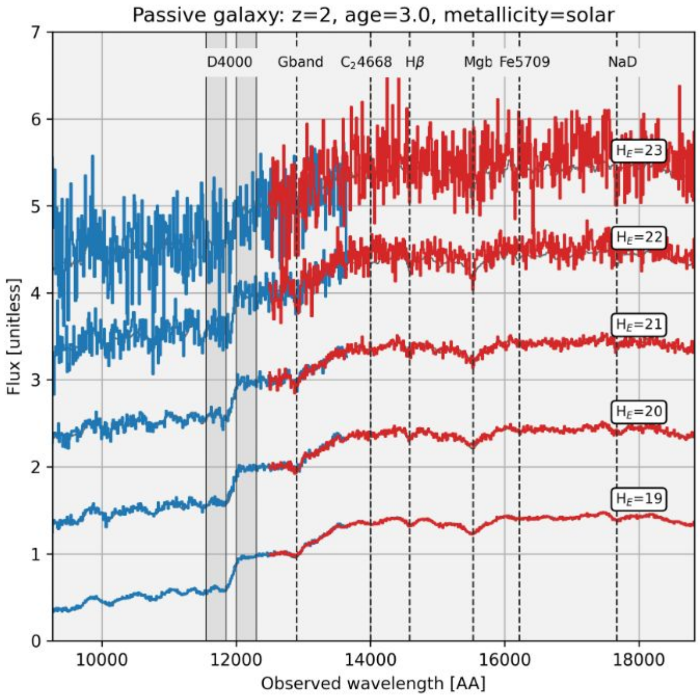
DR1-KP-GEV-2

1. Quenching of galaxies with cosmic time and location (WP5 + WP1)
    a. Probabilistic classification of quenched galaxies (P. Corcho-Caballero, arXiv:2503.15315)
    b. Photometric and spectroscopic analysis of quenching (Z. Mao 🇮🇹)
2. The build-up of the red sequence with time (WP5 + WP1): TBD
3. The evolution of the fraction of passive galaxies and Early Type Galaxies as a function of local projected galaxy density (WP5 + WP1 + WP3): Cressida Cleland
4. Reactivation/quenching of star formation in high-ionisation line AGNs (WP5 + WP9 + WP2 + WP1): Daniela Vergani 🇮🇹
5. The evolution and properties of the most massive galaxies (WP5 + WP4 + WP1)
    a. Detailed study of the most massive galaxies (L. Pozzetti 🇮🇹)
    b. Tensions to simulations with the most massive galaxies (C. Lovell)
    c. Cosmology with cosmic chronometers (M. Moresco 🇮🇹)
    d. Cores of most massive galaxies (R. Saglia, arXiv:2411.01927)

finalized
advanced
started
not yet started
/need data

Challenges

- Most difficult objects to be identified and measured spectroscopically, yet a promising population
- Strict connection to OU-SPE (measurement of breaks and absorption features included) and WP1
- Some science cases requires EDF at full depth and BGS (DR3)
- Q1 mostly focused on photometry so far, but promising ongoing results (see Mao and Pozzetti)
- Significant link with stacking approaches (see Quai et al. submitted to ECEB)



Euclid consortium Italia

Photometric and spectroscopic analysis of quenching

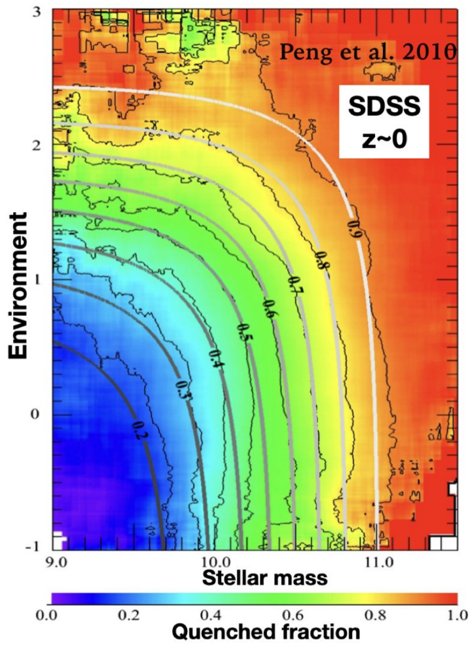
Zhiying Mao (INAF OAS)

Collaborators: L. Pozzetti, S. Quai, A. Enia, W. Hartley, M.Bolzonella, M. Moresco, N. Borghi, and other members of WP1, WP2, WP5

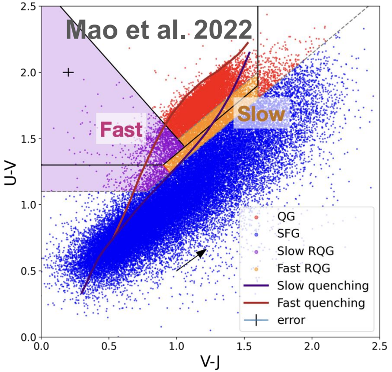
Plan of this project

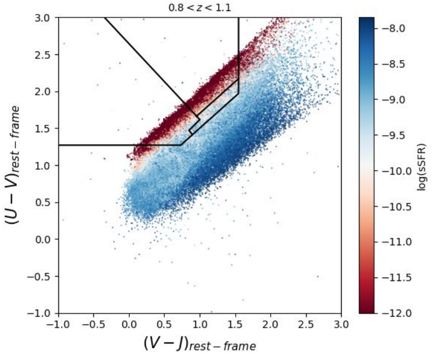
- Galaxy quenching: mainly affected by stellar mass and environment, the mechanisms also differ with redshift
- Galaxy quenching is usually accompanied by morphology transformation

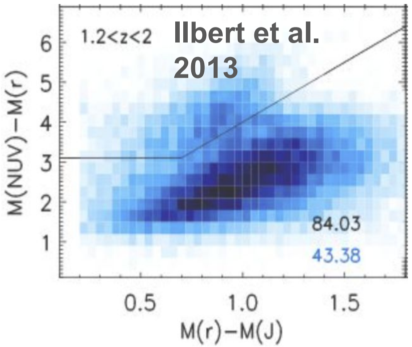
- Classify passive & recently quenched galaxies (RQGs) with rest-frame UVJ diagram and rest-frame NUVrJ diagram
- Separate different quenching timescales (fast/slow evolutionary paths) on UVJ diagram
- Compare galaxy properties between fast/slow RQGs and QGs
  - Stellar mass, SFR, sSFR, SFH timescale, SFH age, age/timescale, (environment)
  - Morphology: Sersic index, radius
- Stack spectra of each population in bins of redshift/stellar mass
  - Hα, VO, CN breaks etc.

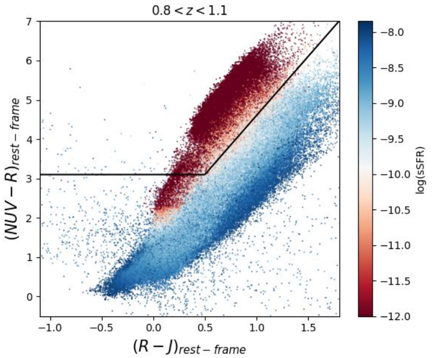


Divide galaxy populations









We use rest-frame UVJ and NUVrJ diagram to classify galaxies. The colours and other physical properties are estimated in Enia et al.

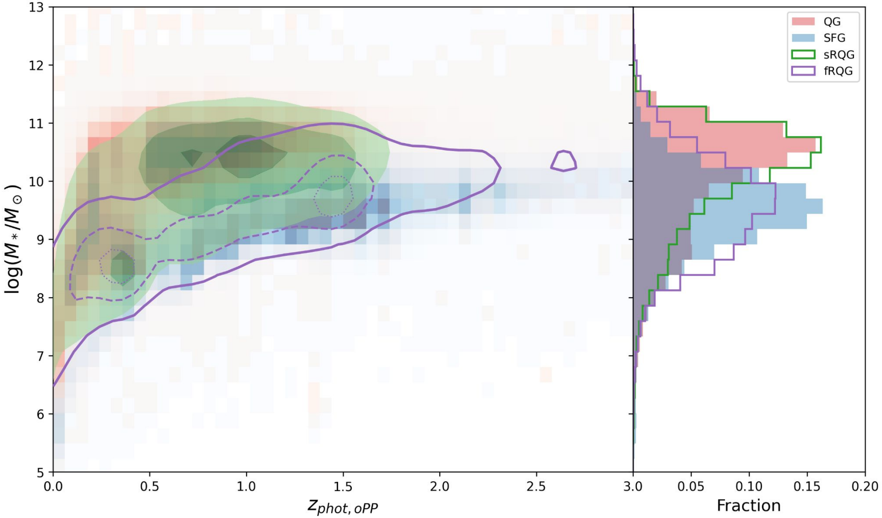
SAMPLE : H<24 0<z<3

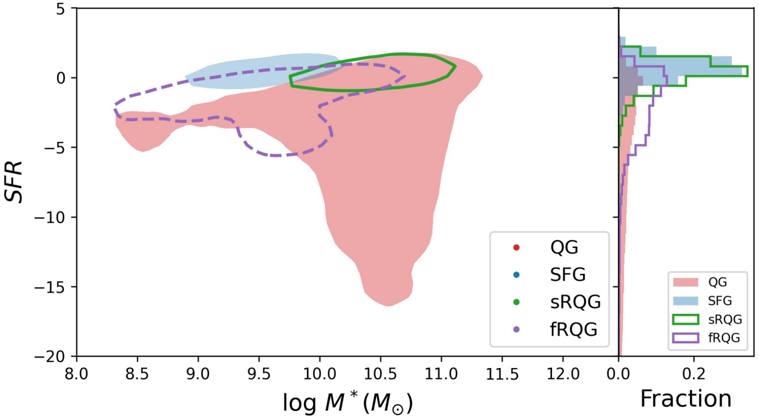
SFG: 5833k, QG: 516k

fRQG:372k, sRQG:144k

Selections agree well with sSFR distribution

Physical property: stellar mass, SFR





- RQGs have intermediate stellar mass and SFR between QGs and SFGs

❖ sRQGs are more massive and have higher SFR (also higher sSFR)

❖ fRQGs are less massive and have lower SFR (also lower sSFR)

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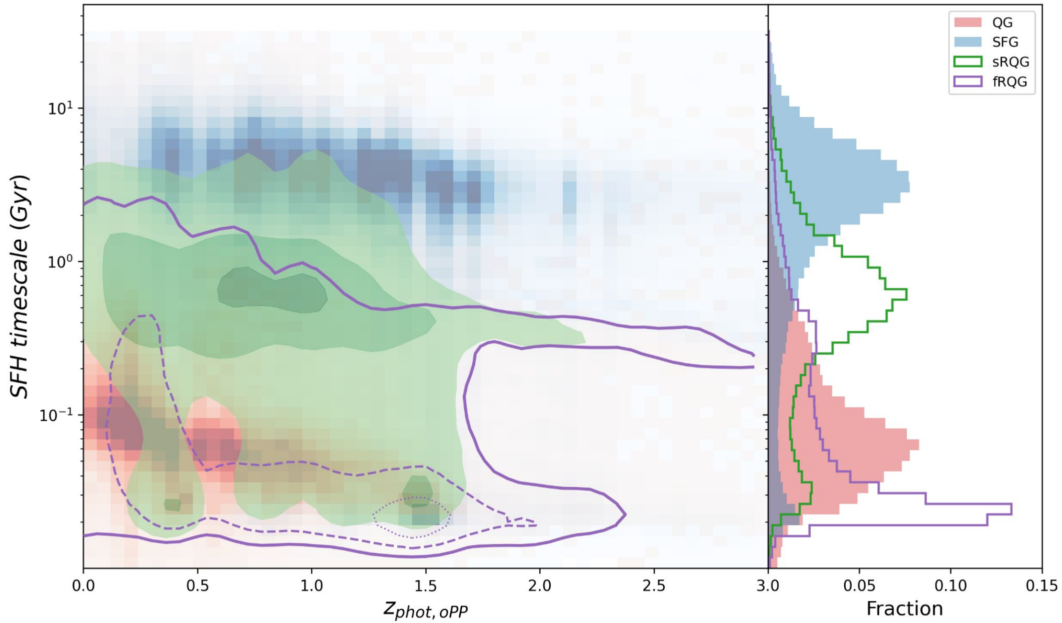
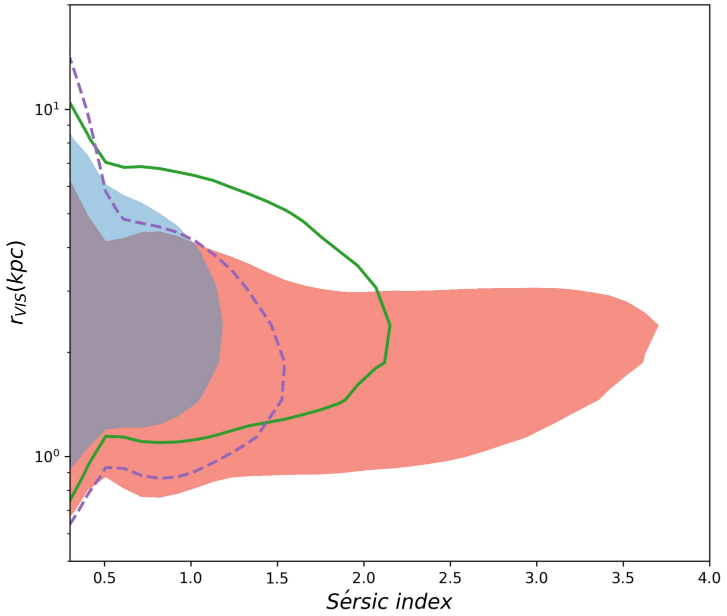
Physical property: SFH timescale



- SFH timescale is shorter for fRQG and longer for sRQG
- QGs have intermediate SFH timescale between fast and slow RQG => they are evolved from both fRQG and sRQG

Morphology property: radius, Sersic index

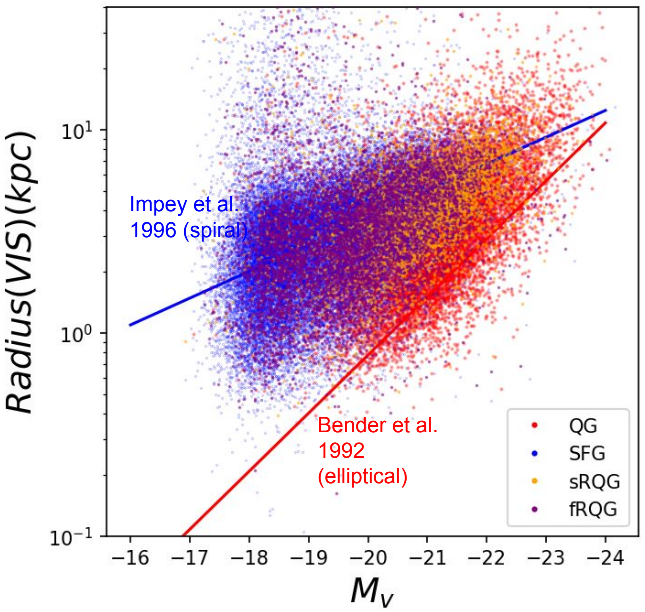


Contours enclose 50% of galaxies in each population.

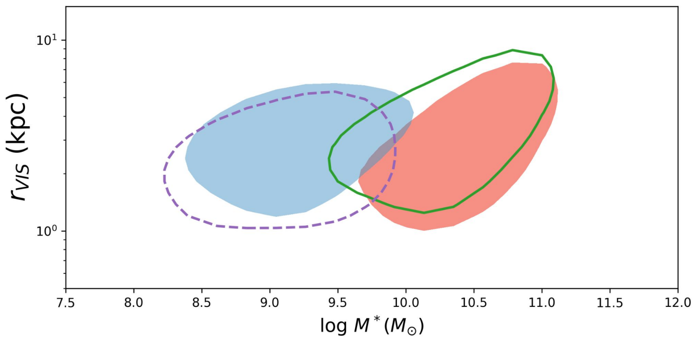
→ sRQGs have extended distribution similar to QG

→ fRQGs have distribution more similar to SFG

Morphology property: radius



- QG and SFG show different radius-Mass/absolute magnitude relations
- RQGs lie between the QGs and SFGs



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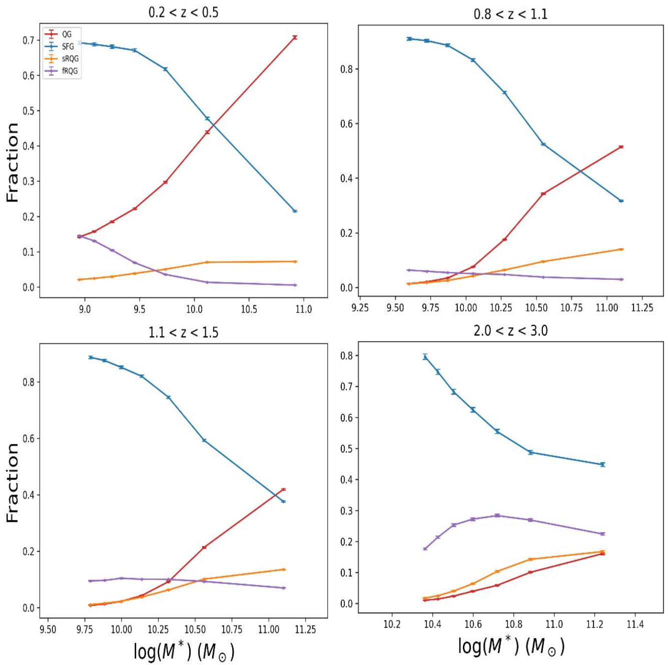
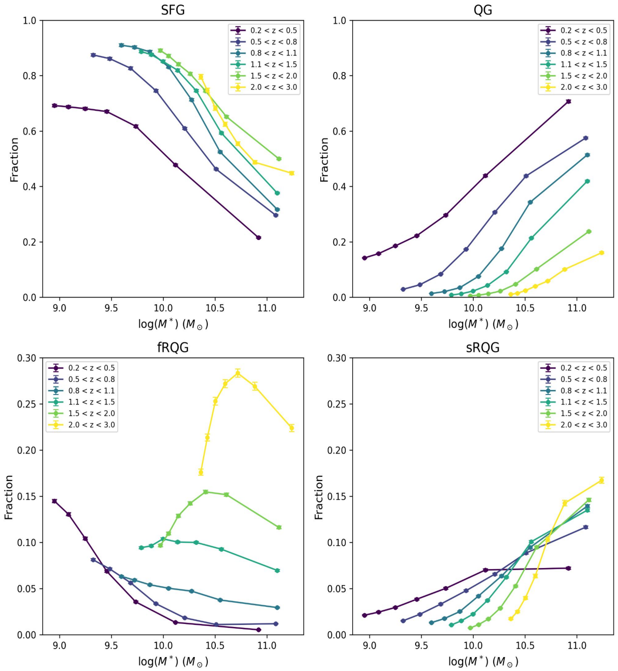
Quenching analysis: population fractions

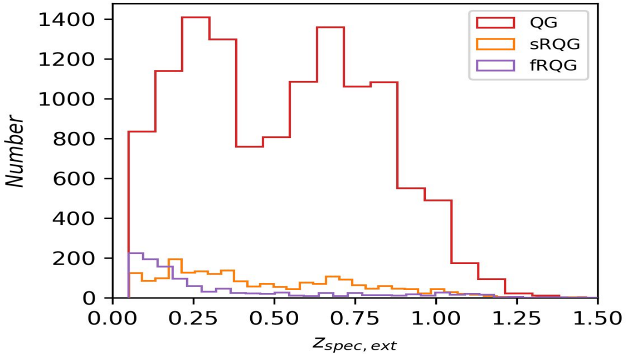


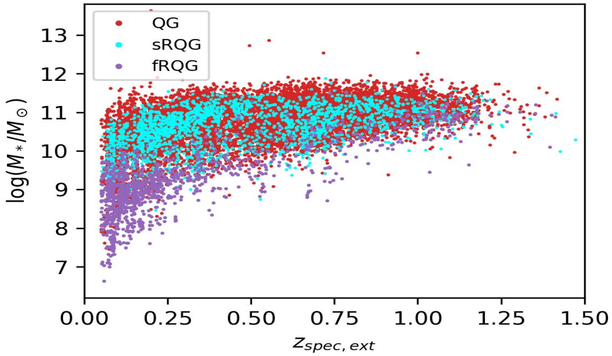


- sRQG fraction increases with stellar mass
- fRQG fraction decreases with stellar mass
- For Massive galaxies:
  - Fast quenching dominate at high-z
  - Slow quenching dominate at low-z

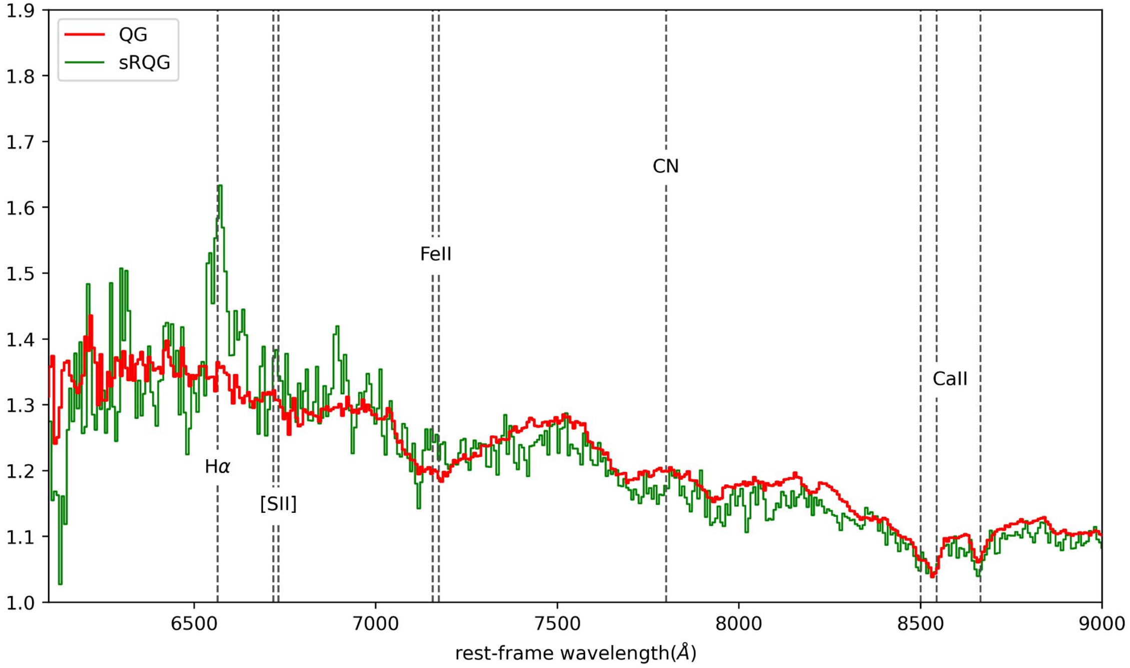
Spectra stacking: stacking sample

- Redshift: external spec-z (DESI, 2MRS, PRIMUS, SDSS etc.)
- Galaxy classification is redone with colours estimated at fixed spec-z
- Stack in 2 redshift bins: 0-0.5, 0.5-1.0
- QG: 12k fRQG: 1138 sRQG: 2081





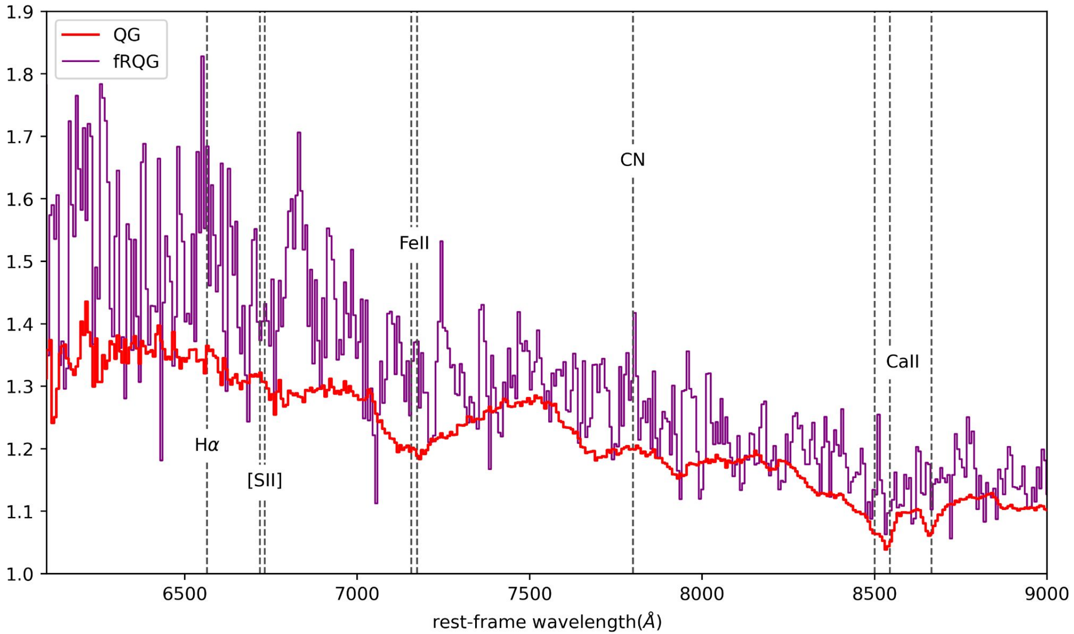
Stacked QG, sRQG: optical



Similar spectra and features typical of passive galaxies

Except Hα in emission

Stacked QG, fRQG: optical



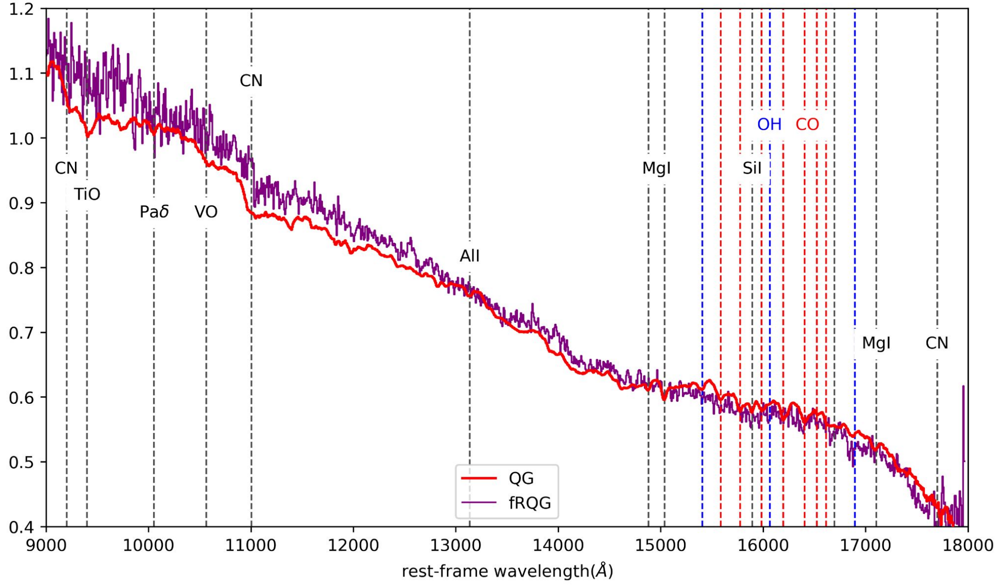
fRQG:

low-SNR spectra

Hα in emission

CaII less strong

Stacked QG, fRQG: NIR

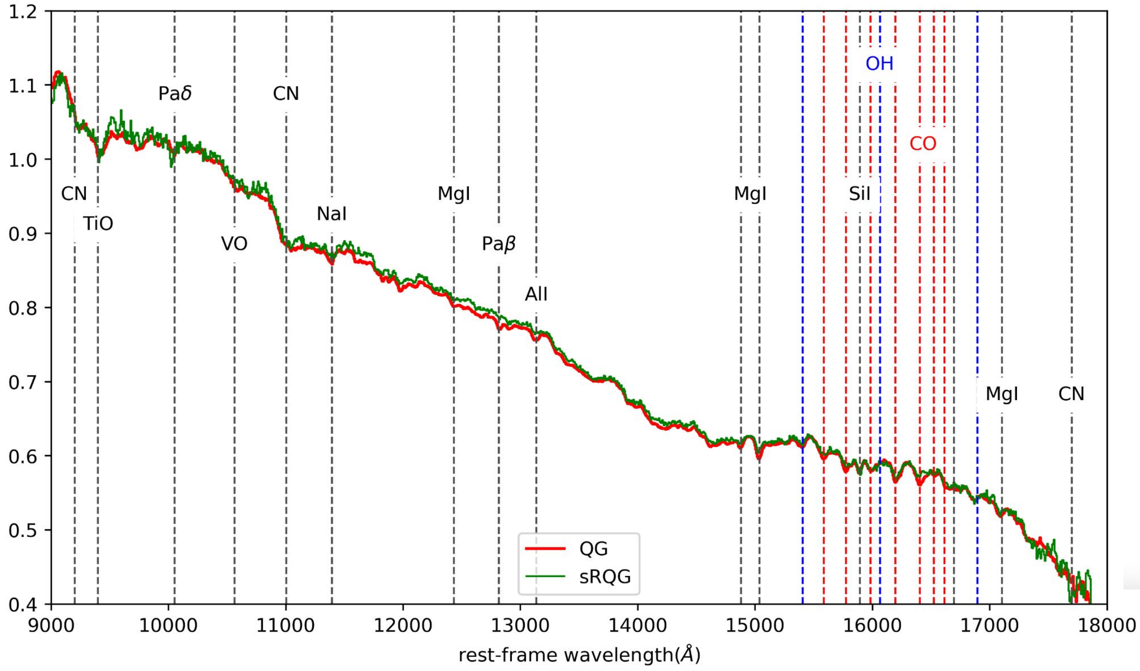


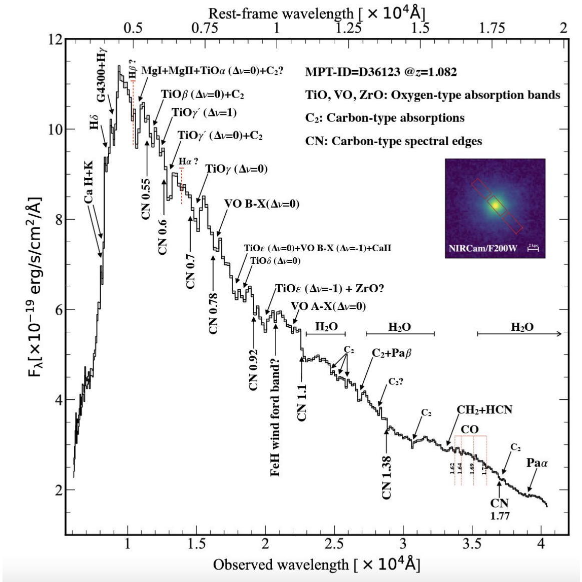
fRQG:

low SNR spectra

Sharper CN1.1 break

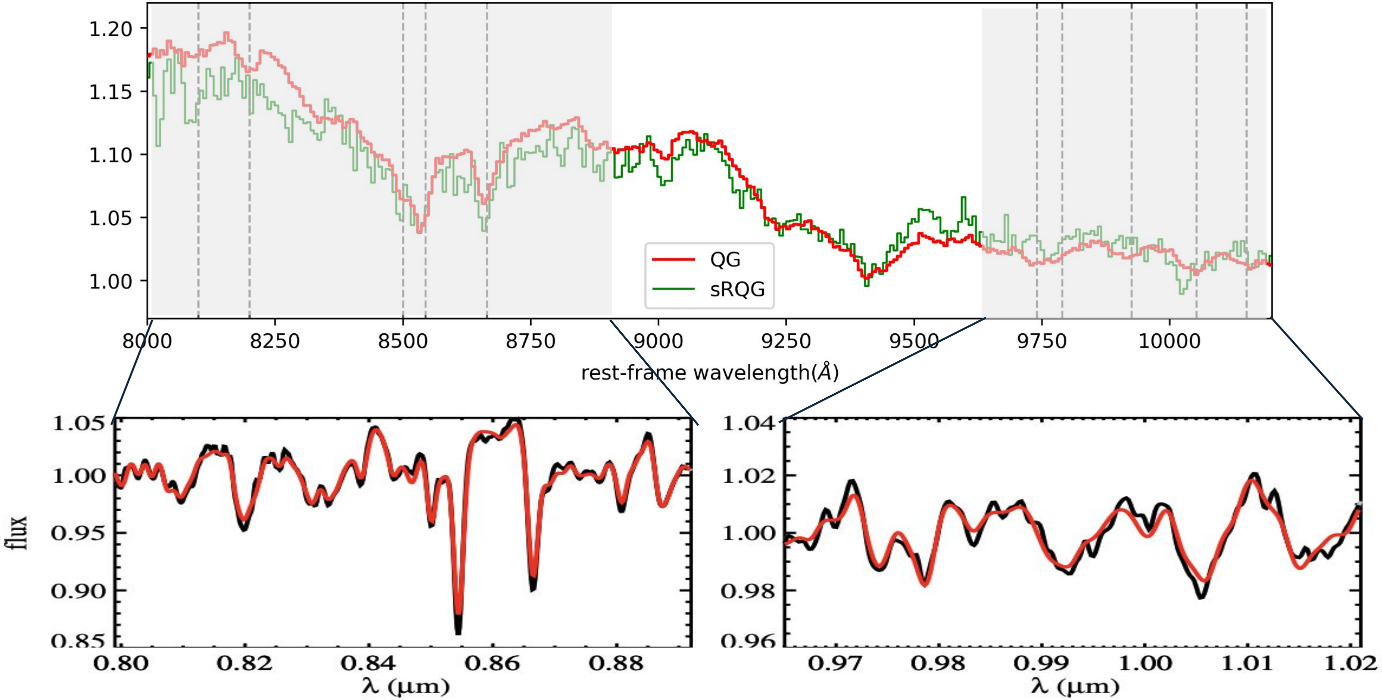
Stacked QG, sRQG: NIR





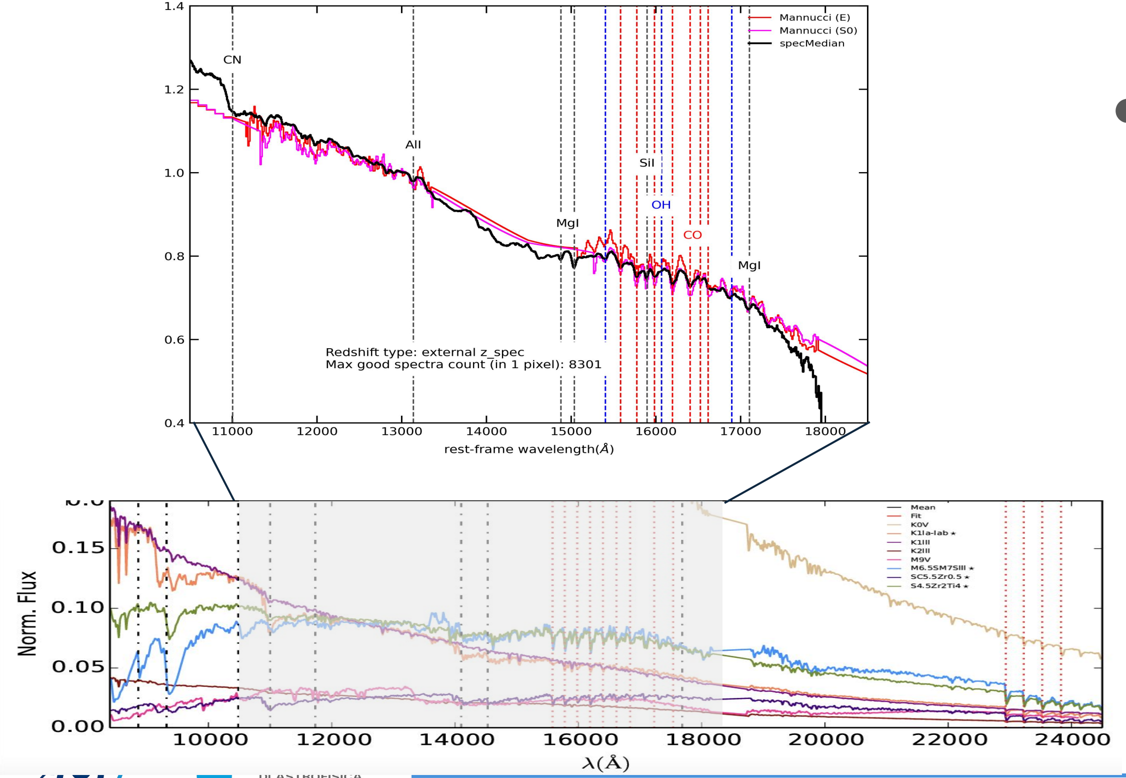
Lu et al. 2024, JWST, z~1, M*~10^10

Compare stacked QG, sRQG to IMF features



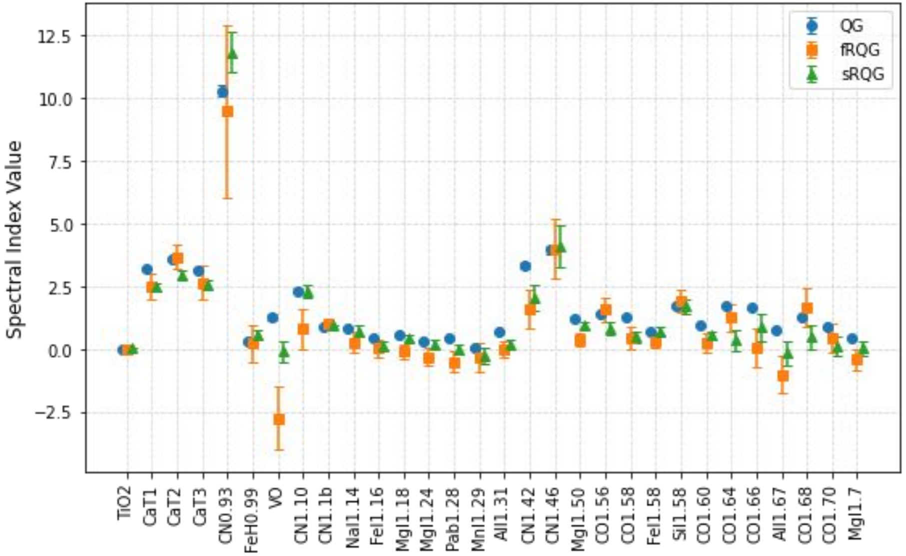
Possible investigation of IMF from NIR features (Conroy+12) at different redshift and stellar mass

Compare stacked QG to template



- Identified many absorption features in the NIR (CO, OH, MgI, …) and edges (CN1.1, CN0.92)
    - comparison to stellar spectra
    - comparison to SP models

Lick indices



Identification and measure of Lick and NIR indices (pyLick)

→ similar in RQG and QG

To do: measure Hα, Paschen series

Summary

- Both NUV-r-J and UVJ diagram separates passive and star-forming galaxies effectively with Euclid photometry
- UVJ diagram can roughly select RQGs, and separated different quenching timescales relatively good
- Both RQG populations have intermediate properties between SFGs and QGs
- fRQGs have short timescales (τ<0.1 Gyr) with morphologies more similar to SFG.
- sRQGs dominate at low-z and high-mass with longer timescales (τ~0.6 Gyrs) and morphologically more similar to QG
- The morphology transformation and star formation quenching are not happening together
- Stacked RQG spectra show features of QG, but RQGs have residual Hα emission

FUTURE:

- Environmental dependence
- Comparison to population synthesis models to derive physical properties from stacked spectra (IMF, Z, age)
- Measure spectral features of 3 populations to tell their differences