Extreme emission line galaxies in J-PLUS

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Astrofísica y física de altas energías
CEFCA
FONDO DE INVERSIONES DE TERUEL
GOBIERNO DE ARAGON
MINISTERIO DE CIENCIA E INNOVACIÓN
Plan de Recuperación, Transformación y Resiliencia
Financiado por la Unión Europea NextGenerationEU

Summary

- 1. Introduction and motivation
- 2. Detection of extreme emission line galaxies (EELGs) with J-PLUS
  - Sample selection pre-2023
  - New sample selection (iSDSS)
- 3. Detailed analysis of J-PLUS EELGs
  - Spectroscopy
    - Comparison with other analogs and high-z objects
  - Morphology
  - Other observations
- 4. Other topics
- 5. Summary

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- Why study star formation in galaxies?
  - Shapes the evolution of the galaxies
  - Changes across the history of the Universe

ESO, A McLeod et al.

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    (they die very fast: if there are massive stars, there has been very recent star formation)
    - UV continuum, IR luminosity, Radio, X-ray
    - Emission lines (HII regions)

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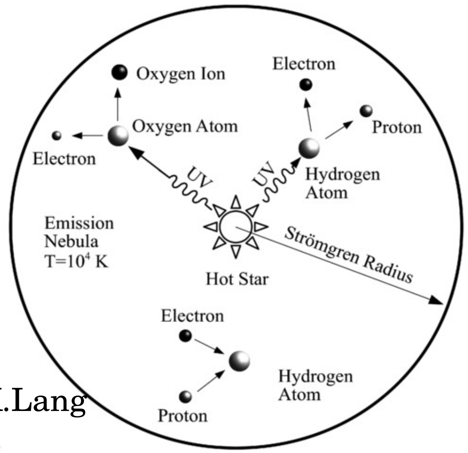
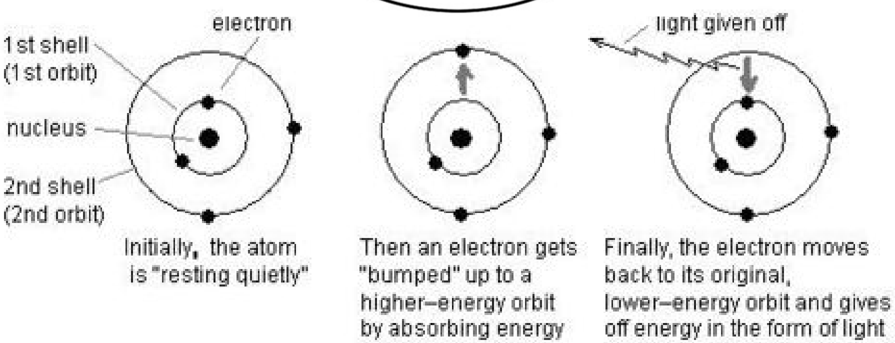


K.Lang



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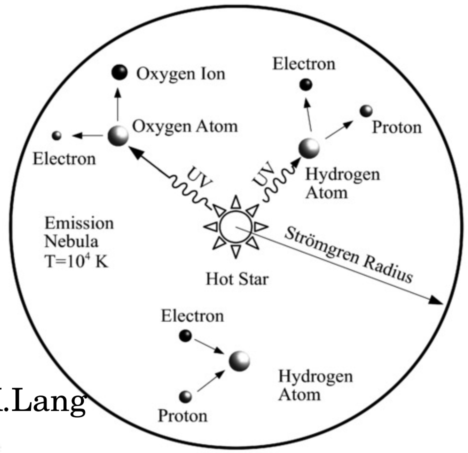

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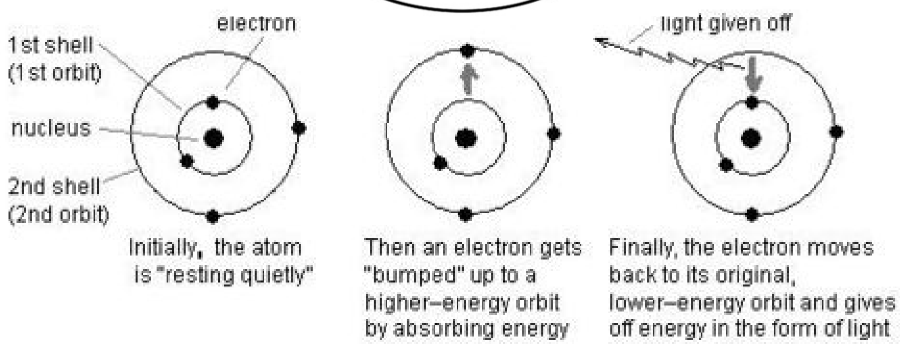

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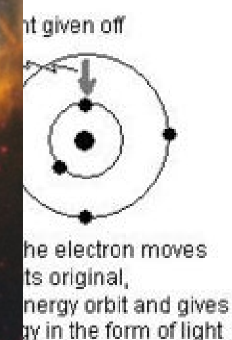

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    - Blue colors
    - Low metallicities
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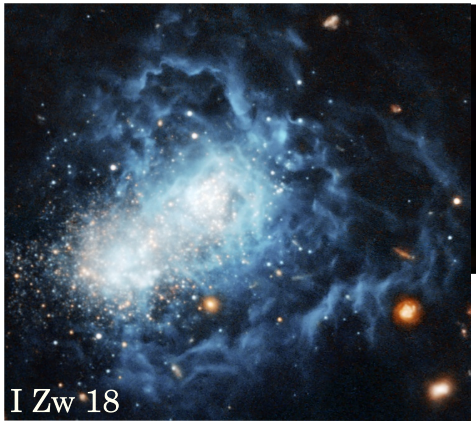
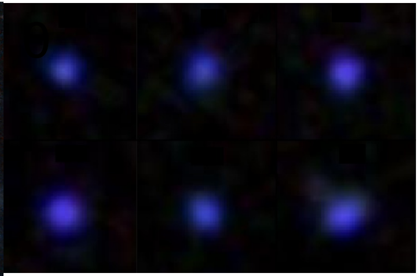


NASA, ESA, and A. Aloisi



Blueberry galaxies (Yang et al. 2017)

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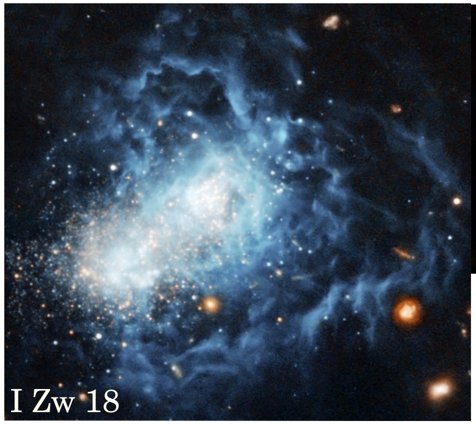
- Similarities between very early galaxies and some local EELGs
  - Low masses, low metallicity



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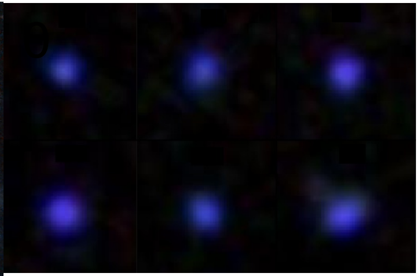
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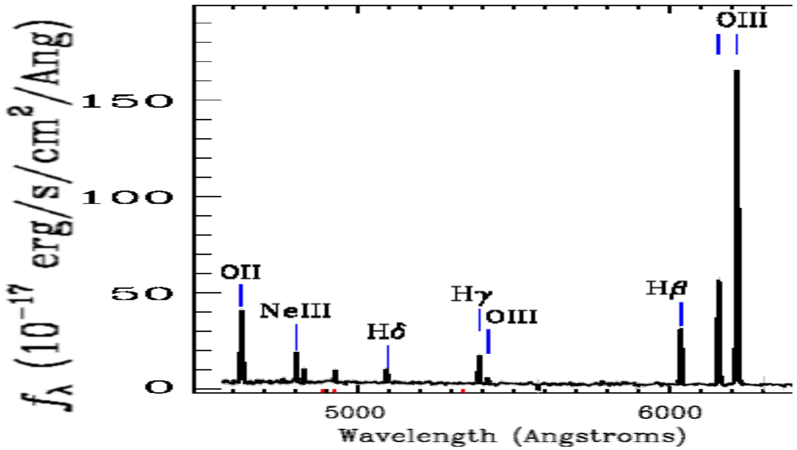

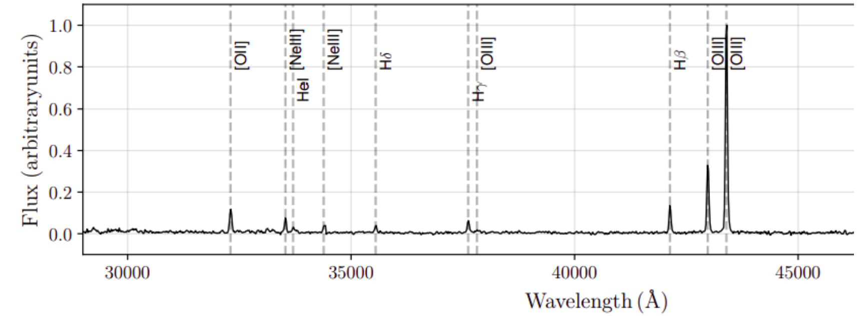

Early Universe galaxy (Katz et al. 2023)

Goal and motivation

- Create a complete census of EELGs in the local Universe and follow them up
  - To fully understand their statistical properties
  - To identify those that are the best analogs of the first galaxies in the Universe
    - Local EELGs can be studied in more detail than distant galaxies

For that, we need ...

- A very wide survey
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- 5σ depth 20.3 – 21.5 mag
- 12 Filters, 7 narrow-medium

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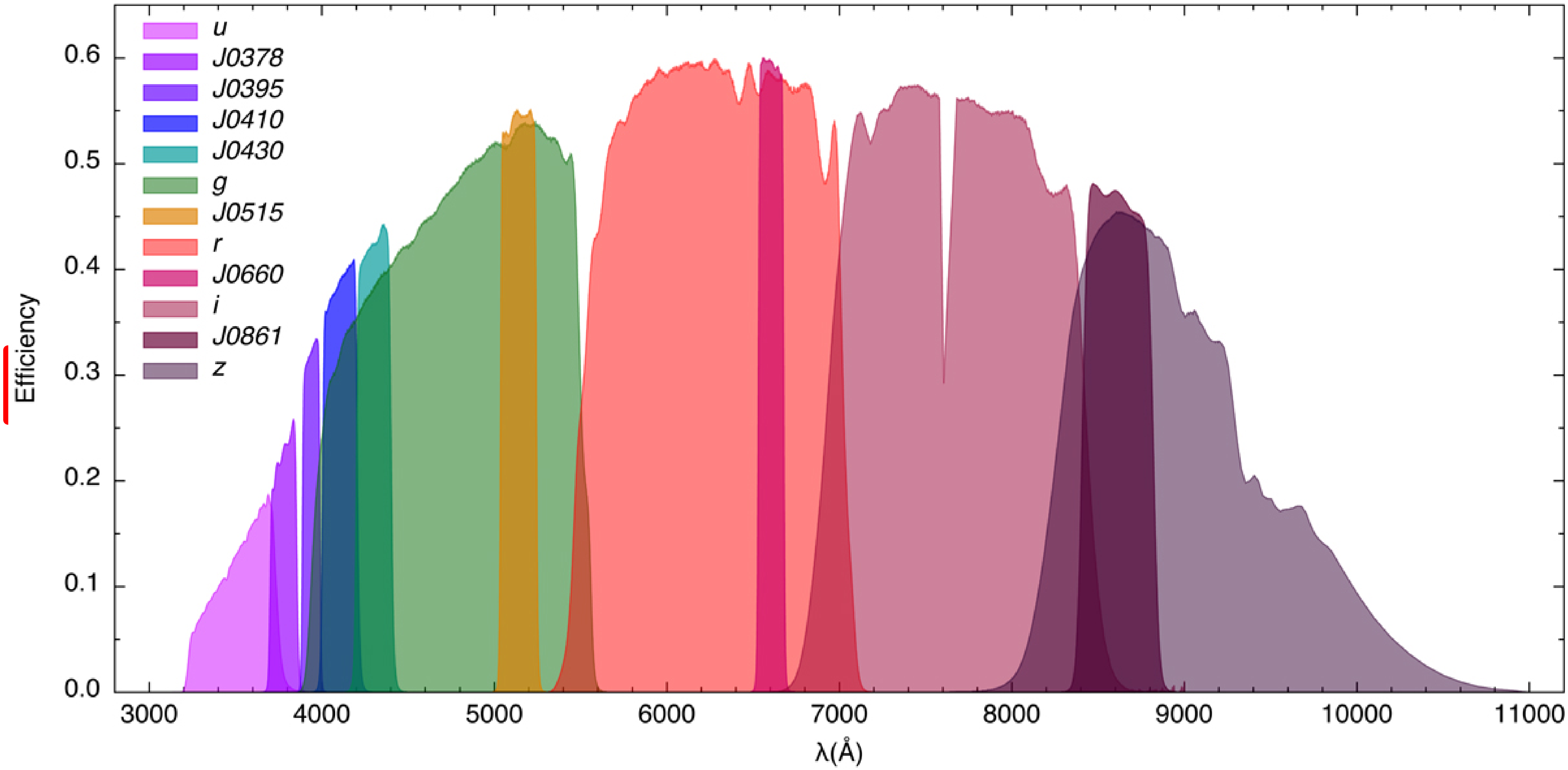

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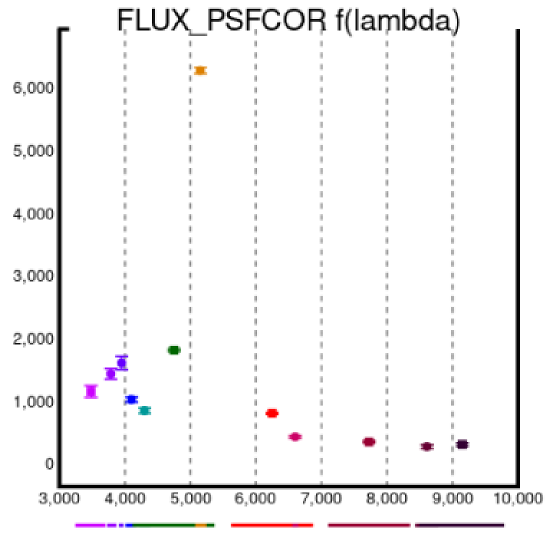

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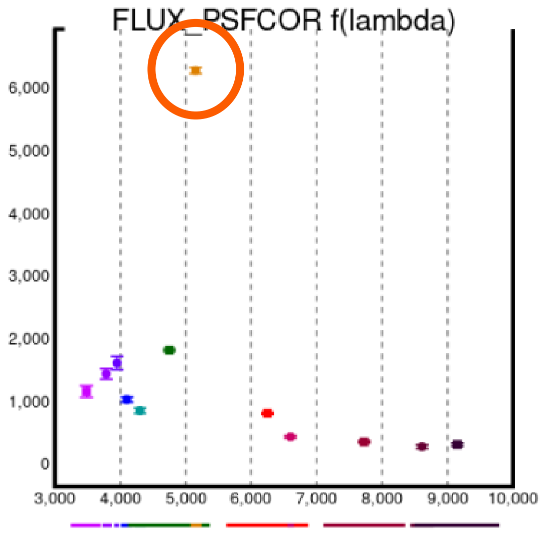

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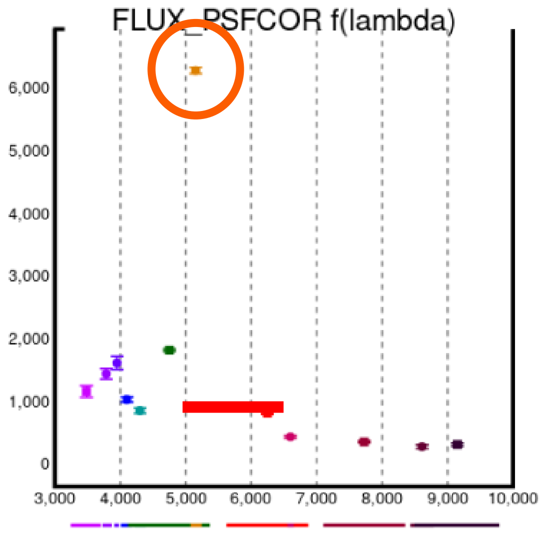

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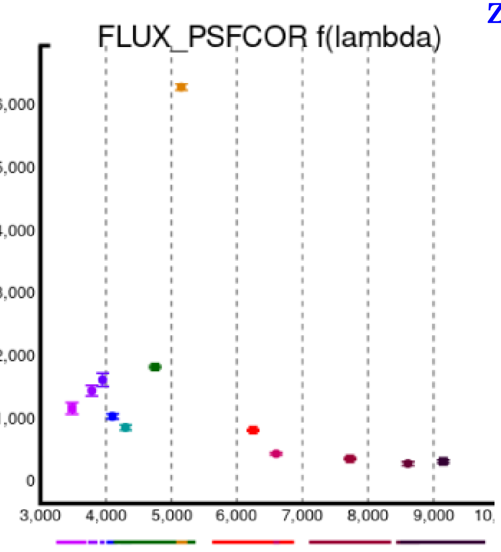

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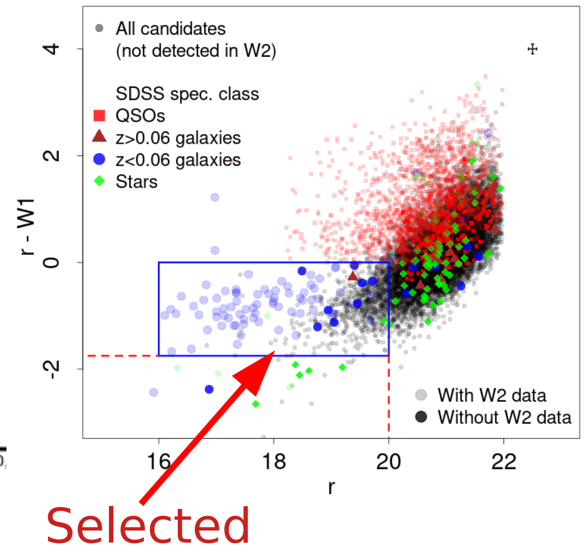

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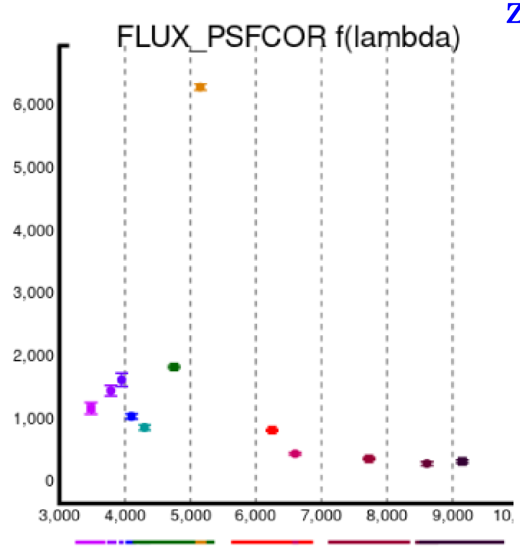

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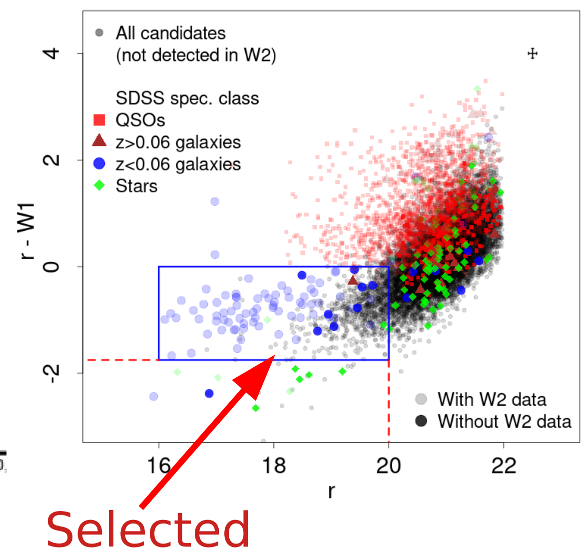

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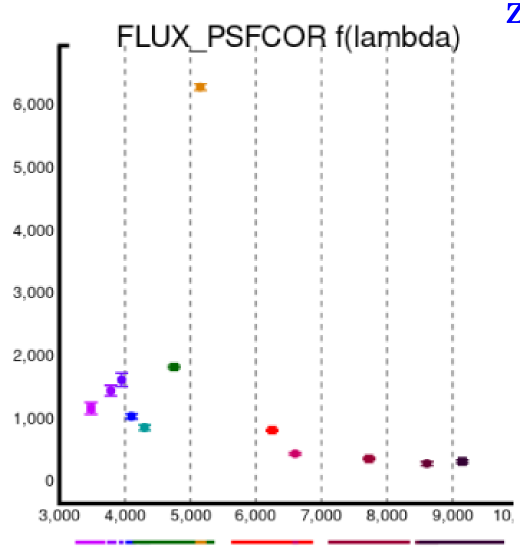

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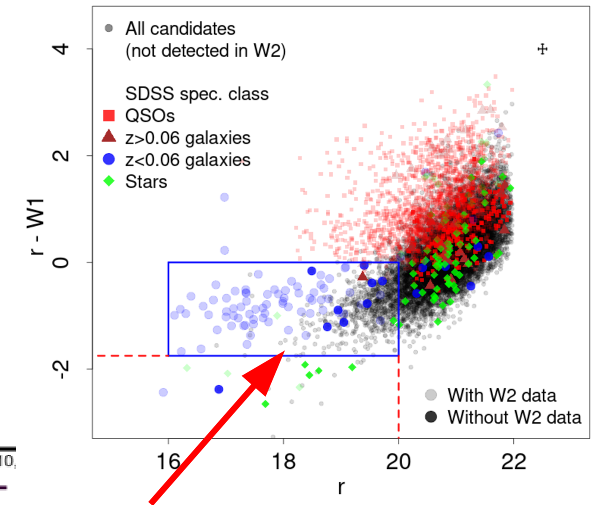

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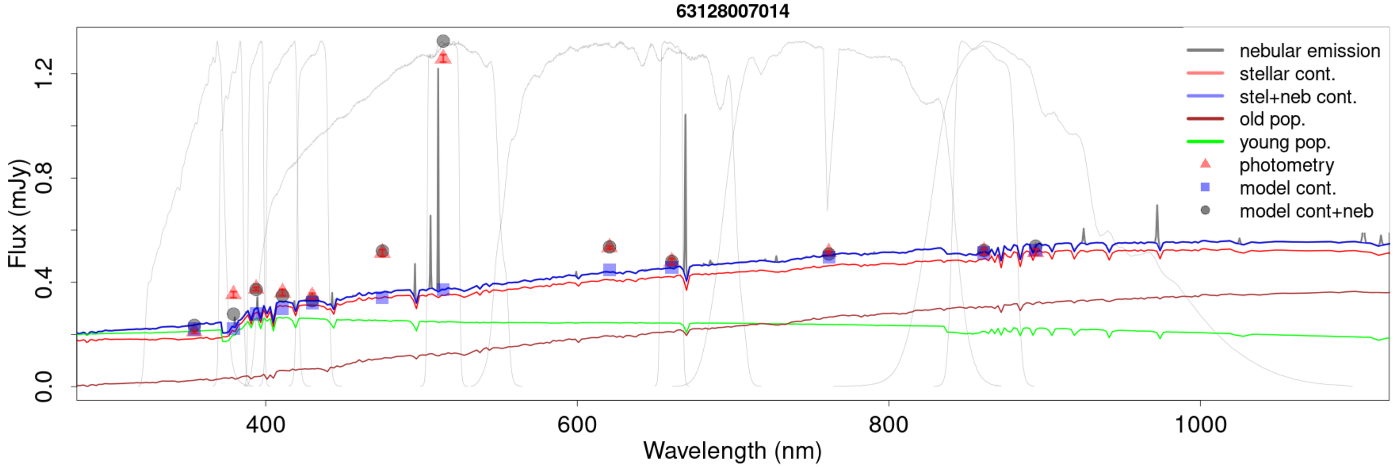


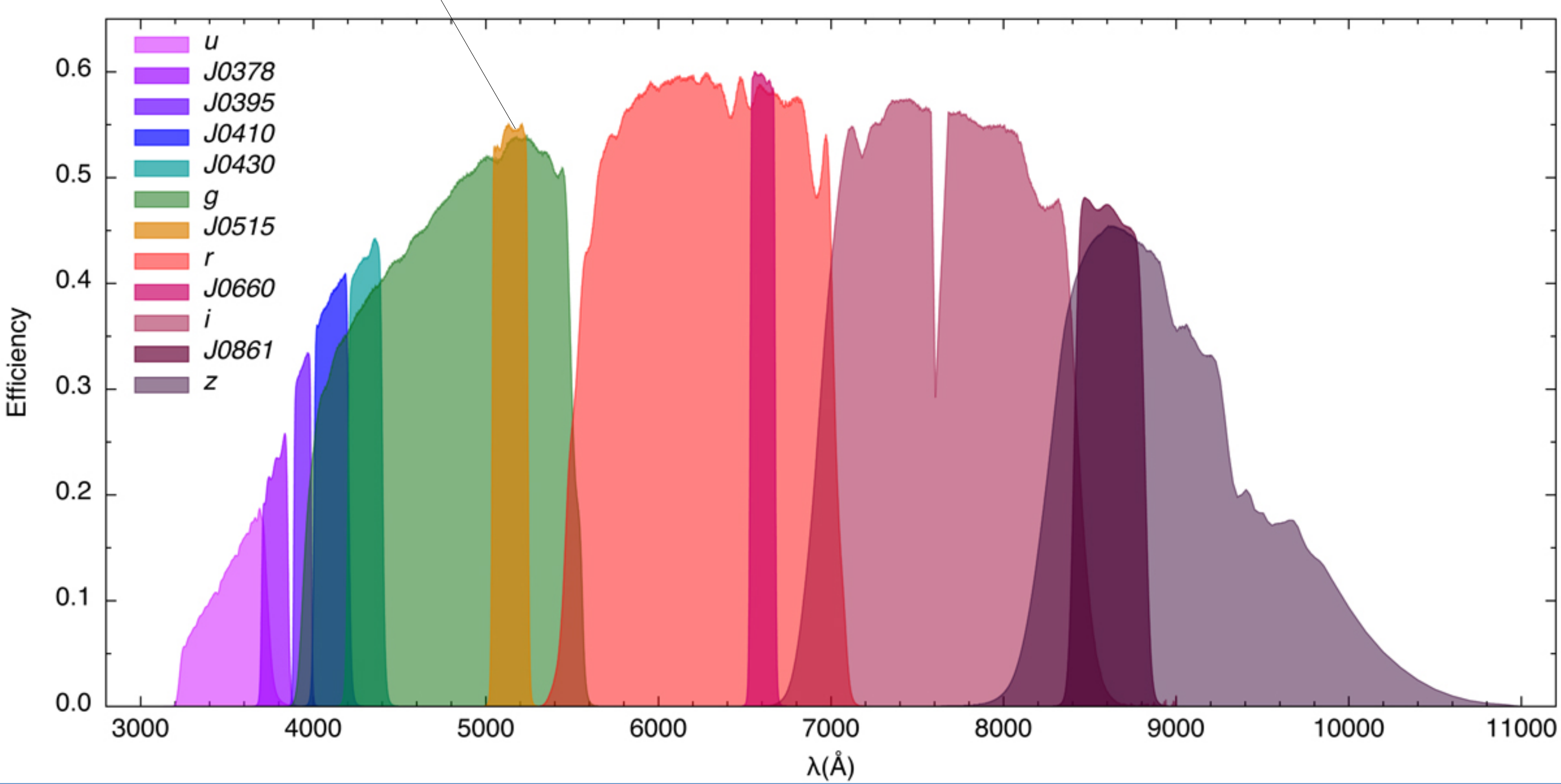
3. **SED fit to extract physical information**
   - Compare light distribution to theoretical models

- Very young burst (<=6 Myr)
- Low-mass galaxies
  - Median value $\log(M_*/M_\odot) \sim 8$ $M_\odot$ (7.5-9)
- Low dust extinction E(B-V) ~ 0.15

The previous EELG samples

3 filters - 3 redshift slices

[OIII]5007 emitters



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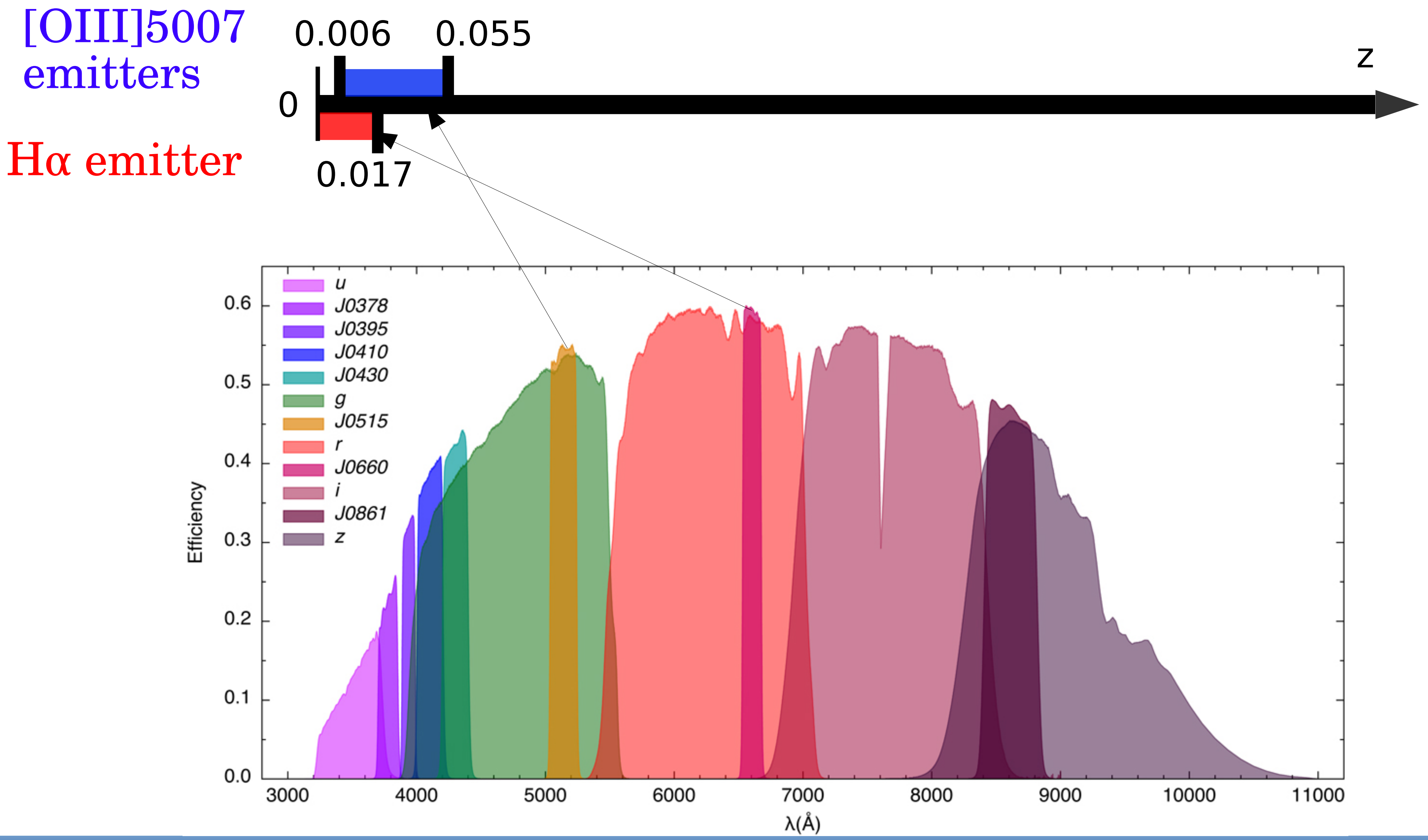

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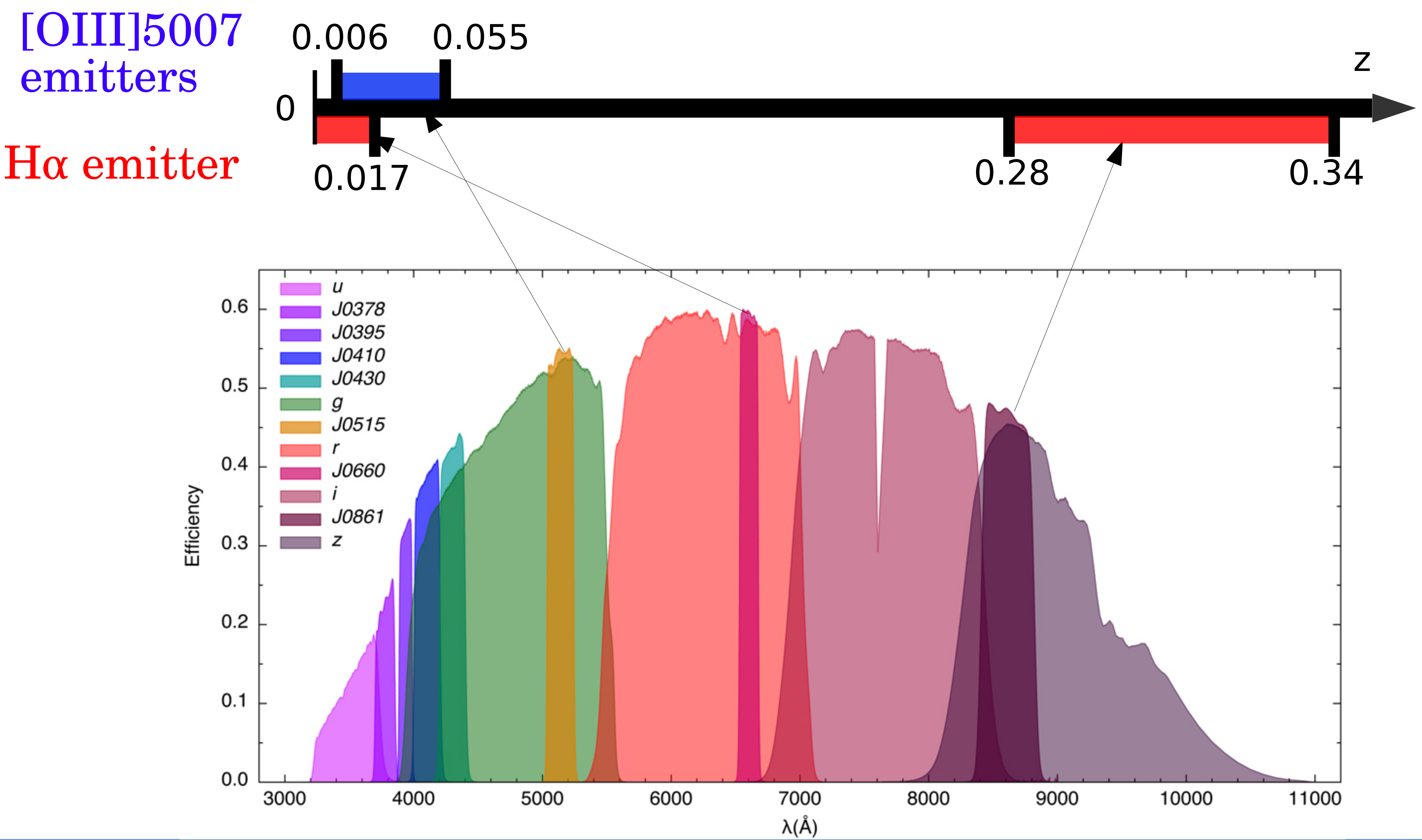

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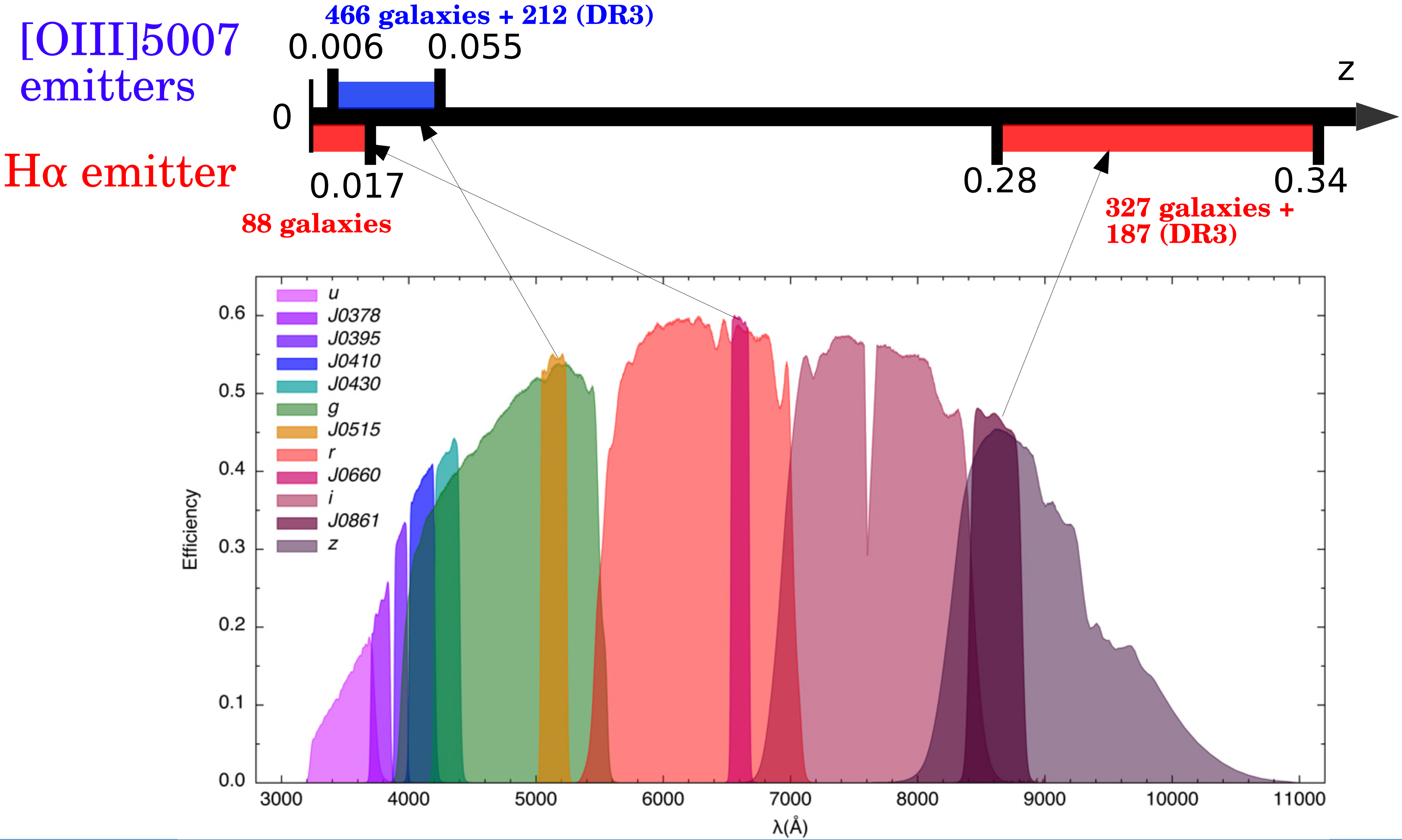

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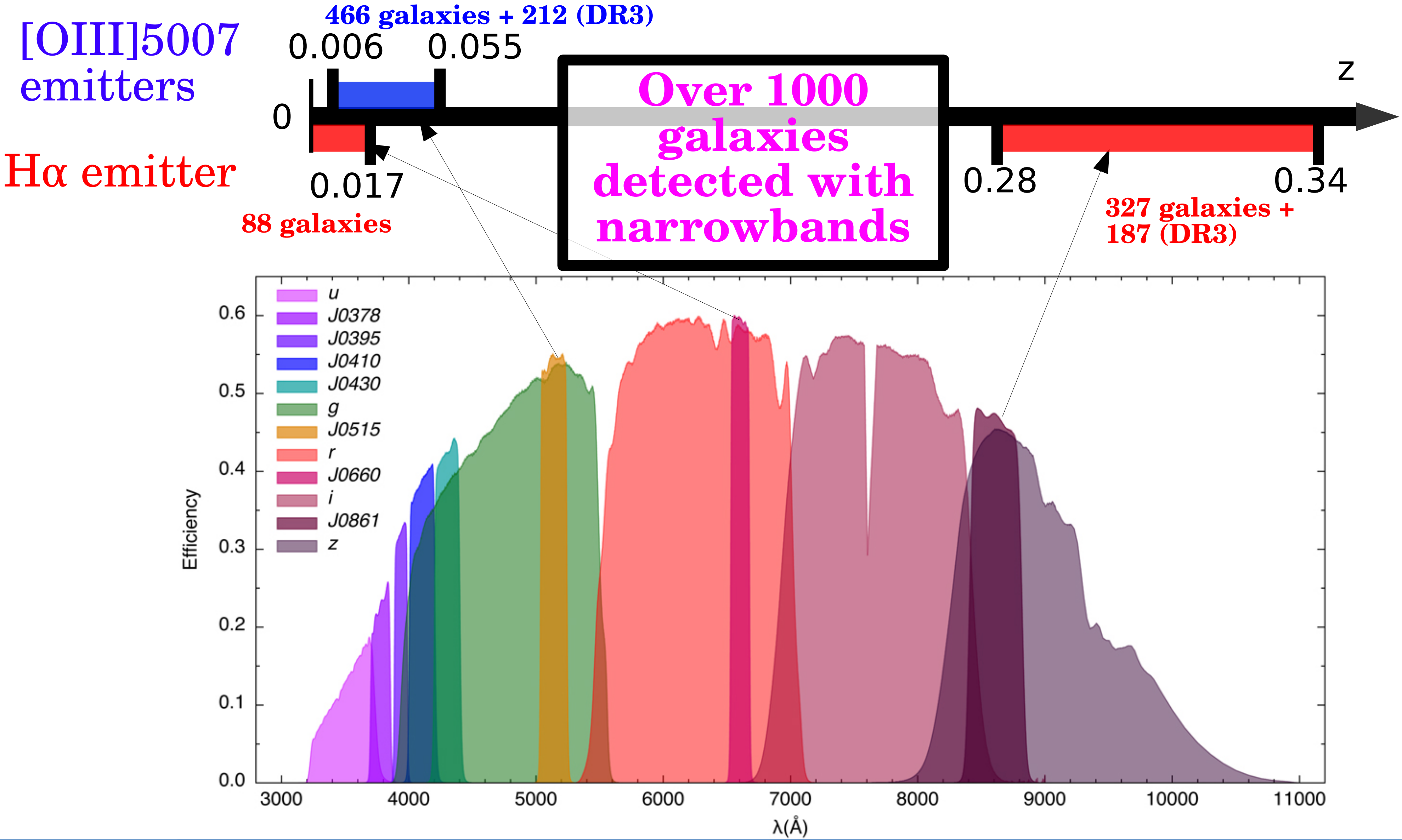

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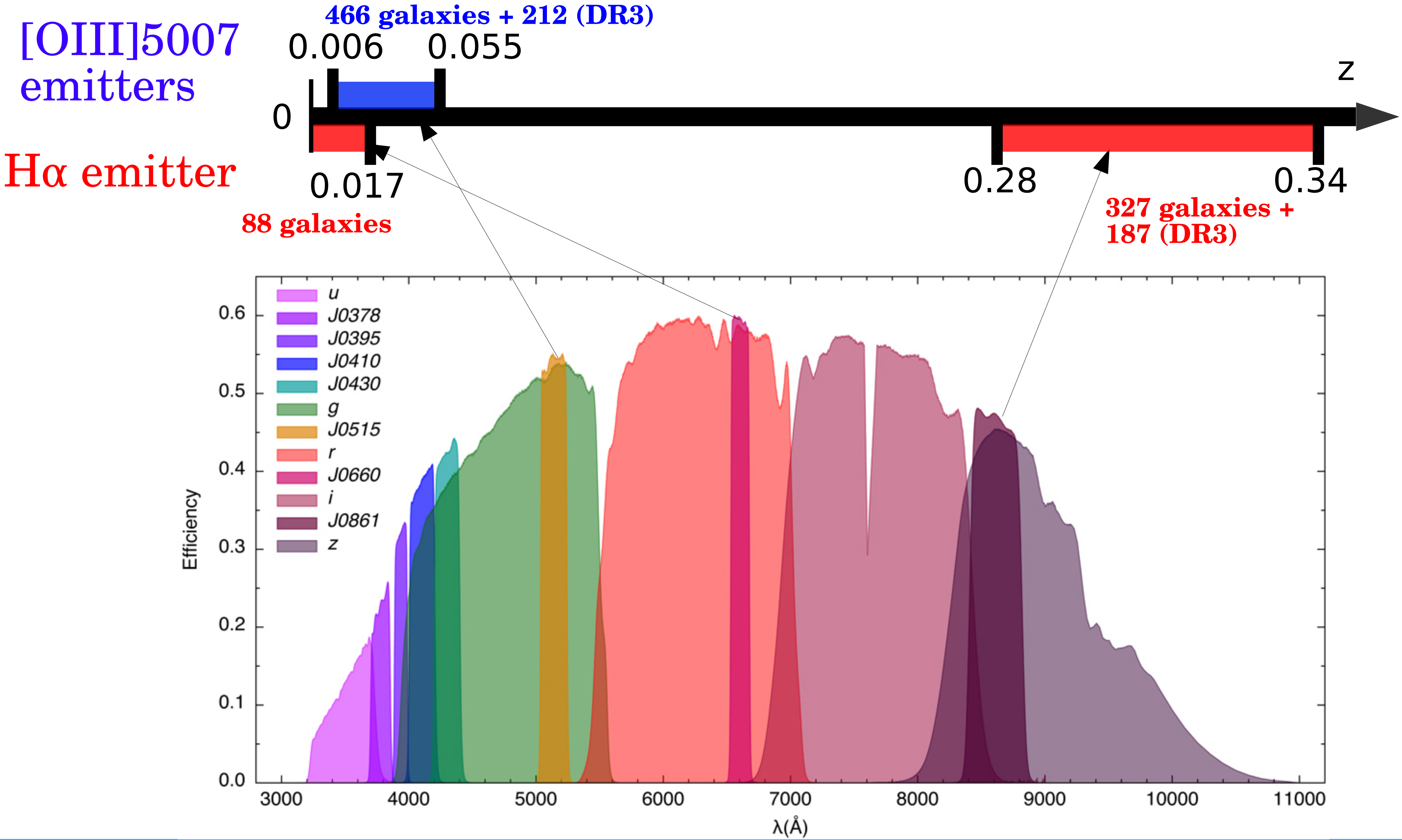
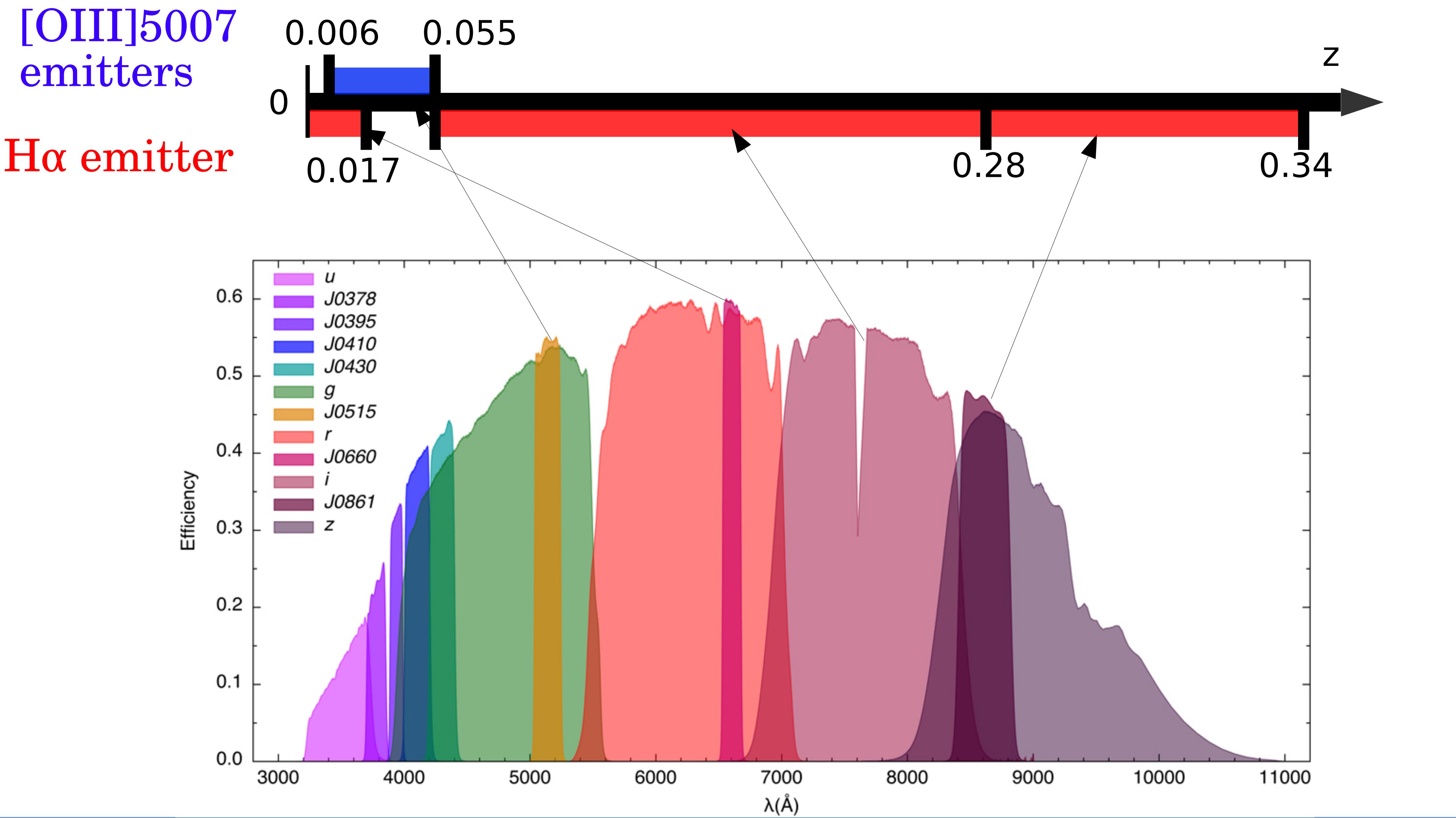


2023 New sample

Final redshift gap covered

With a tip from F. Arizo



New sample selection – iSDSS

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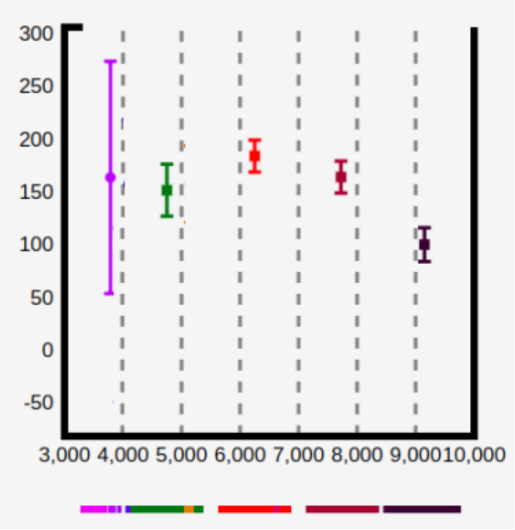
2. Broadband-only surveys are limited
    - All nearby filters may be contaminated by emission lines

<u>J-PLUS can measure accurately strong emission lines using broadband filter:</u>

We can use a nearby narrowband filter to estimate the continuum



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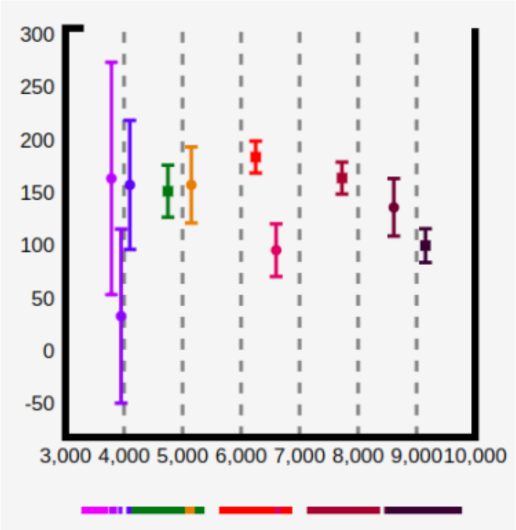

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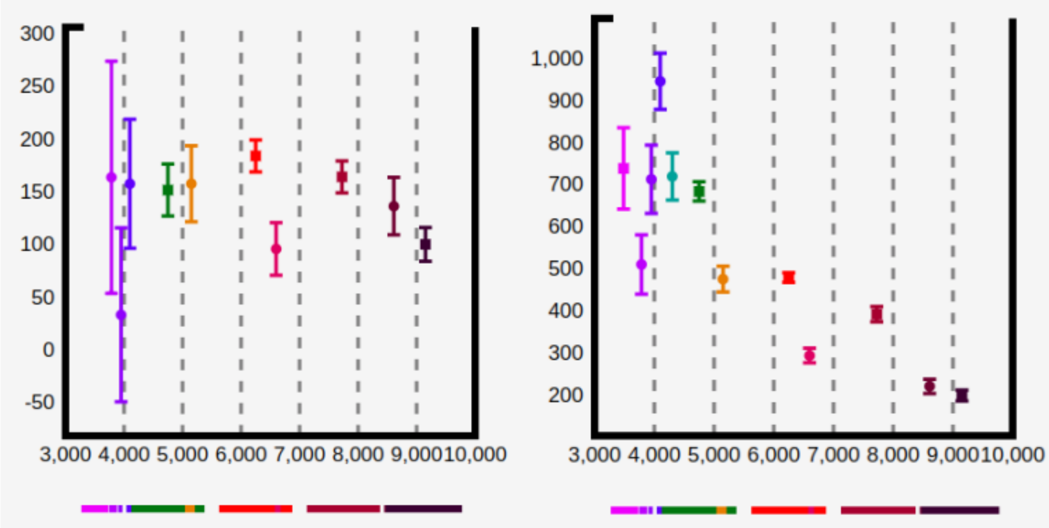

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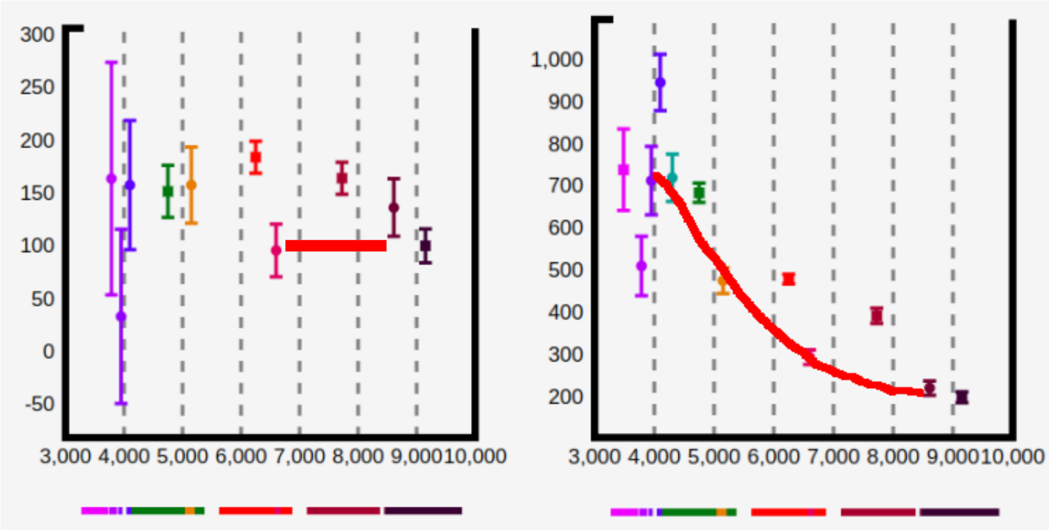

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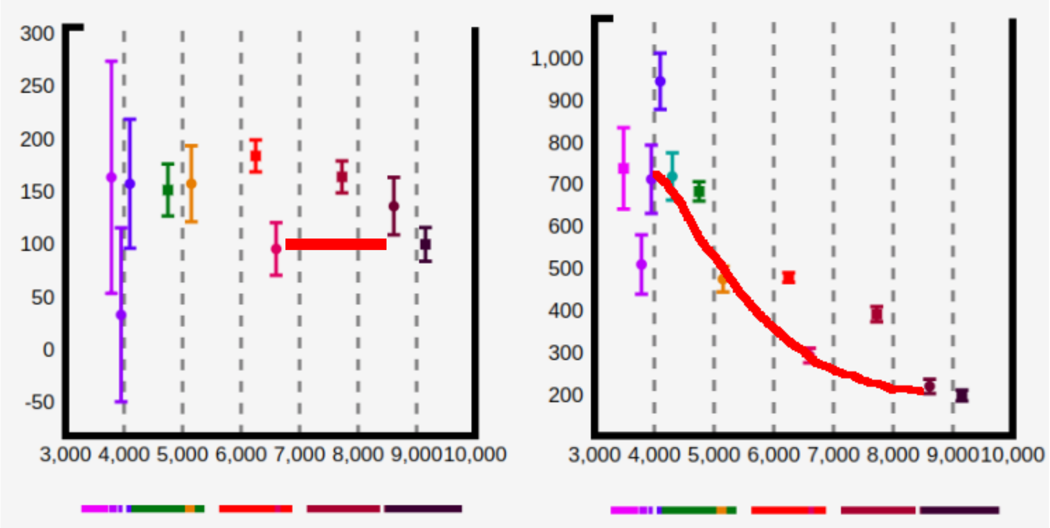

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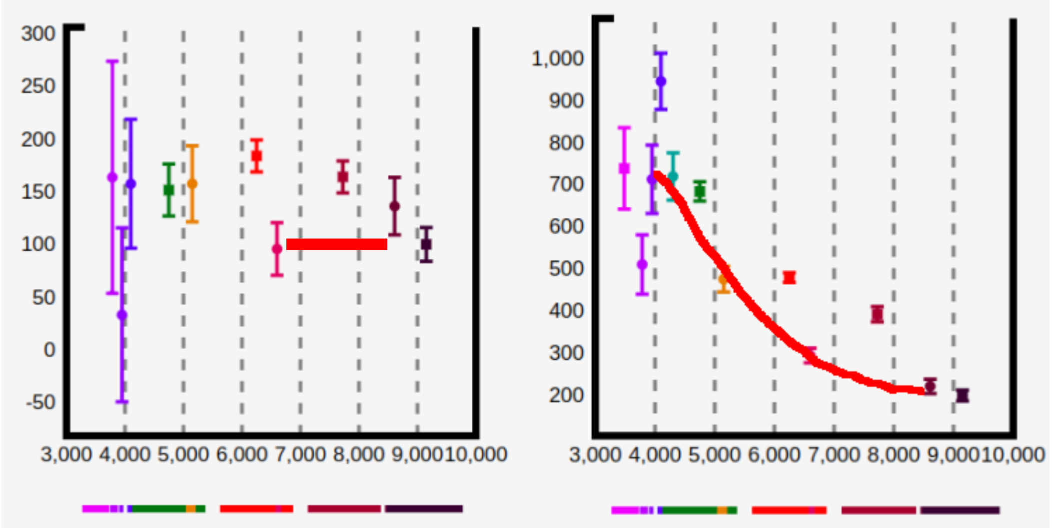

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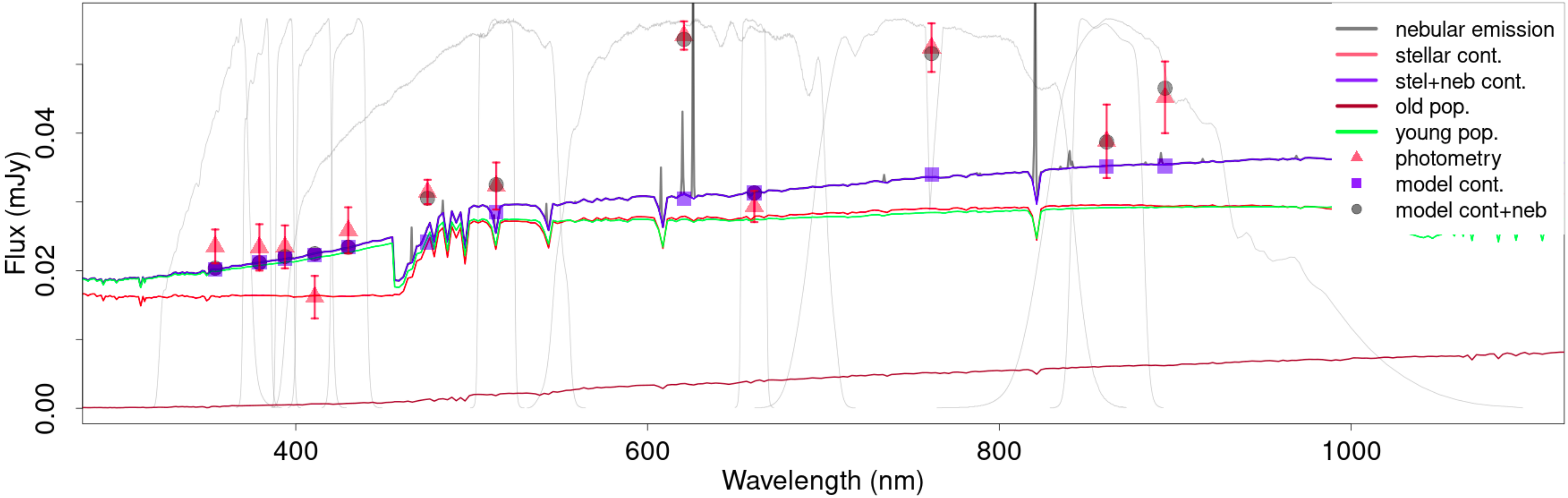

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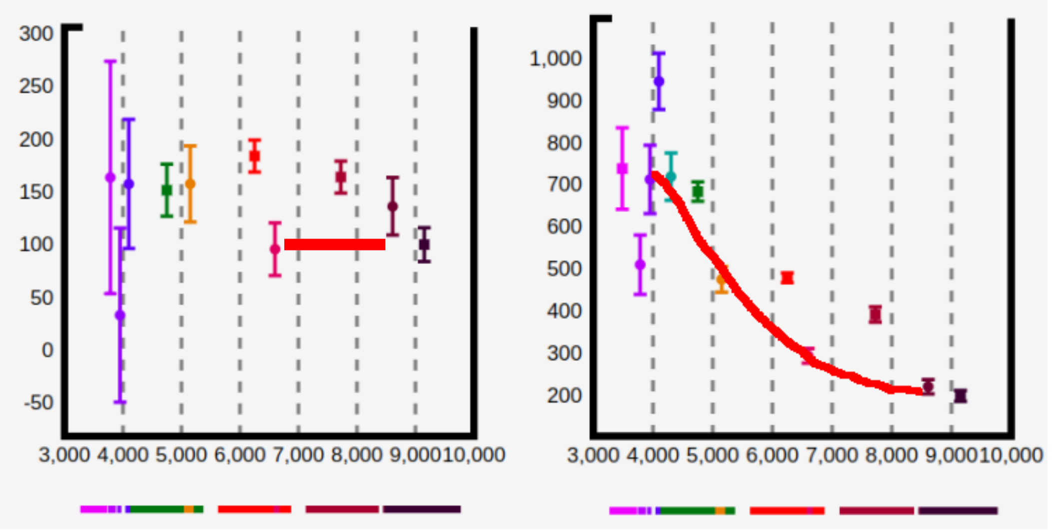

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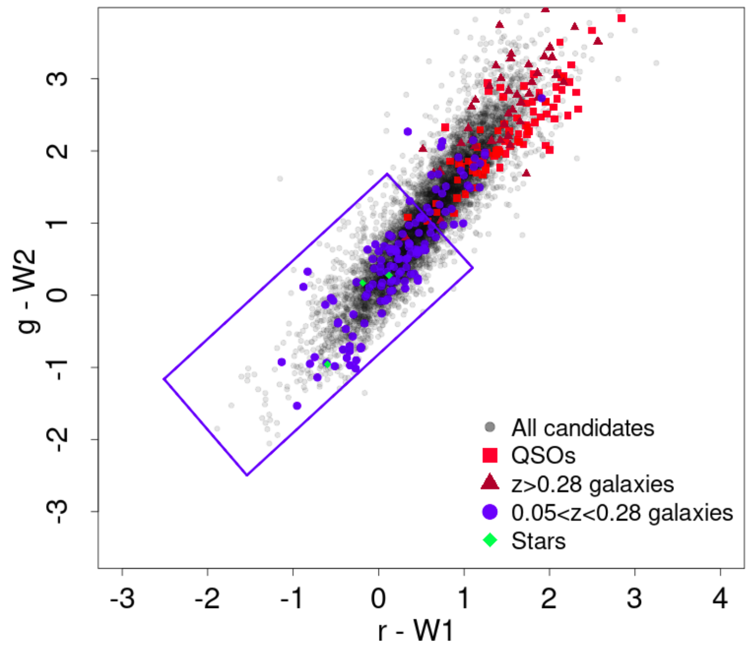
  - More dusty



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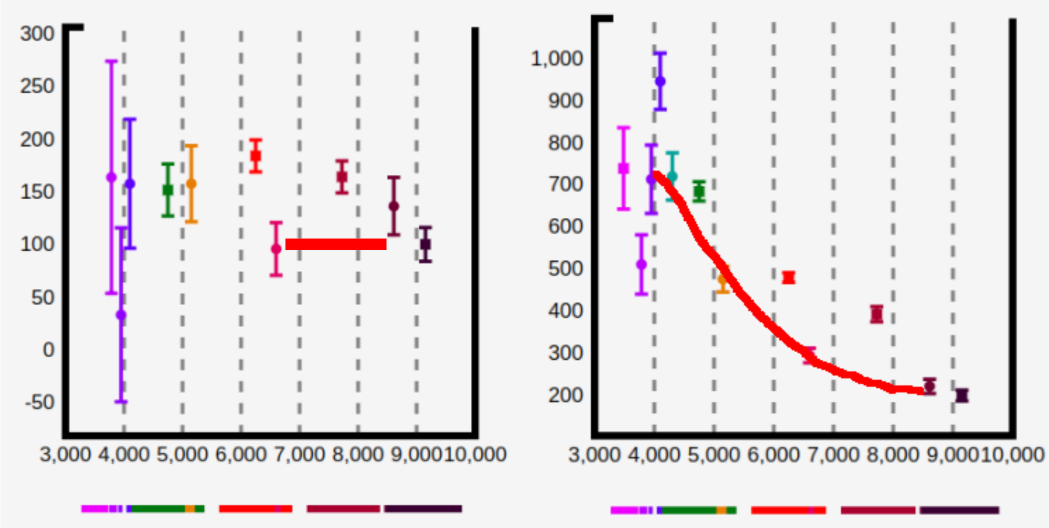

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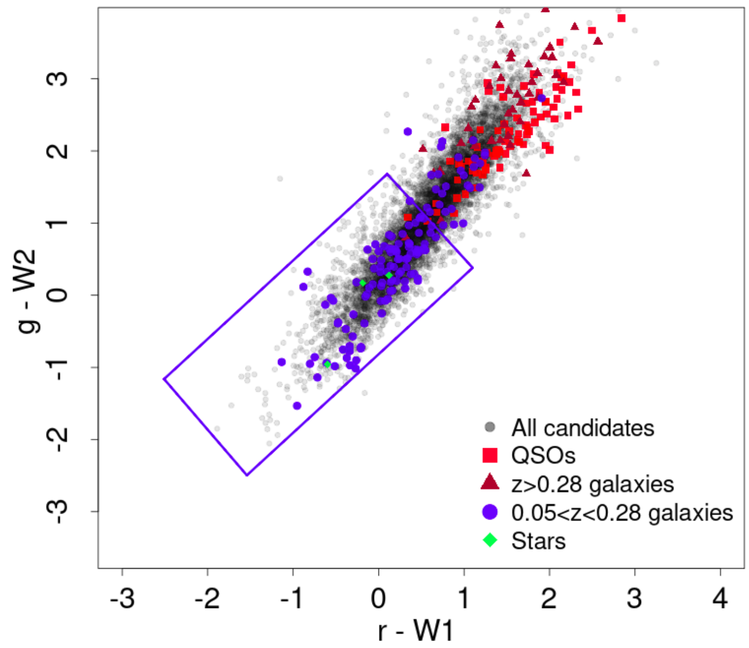

3. Detailed analysis of J-PLUS EELGs

Follow-up spectra of the EELGs samples

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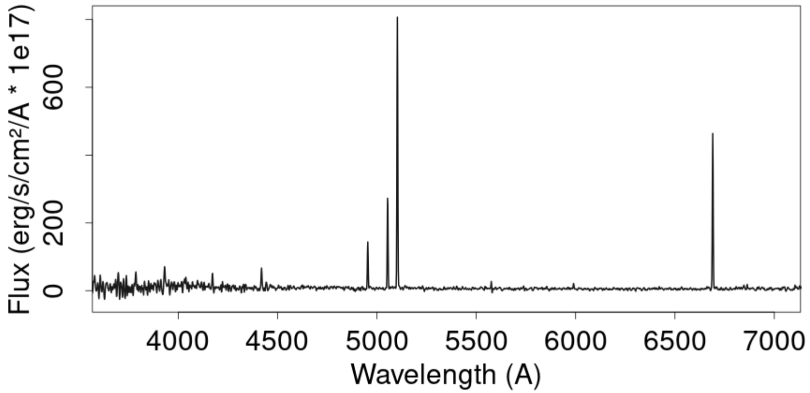

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First results presented at conference in Marseille in July 2023

Paper in preparation

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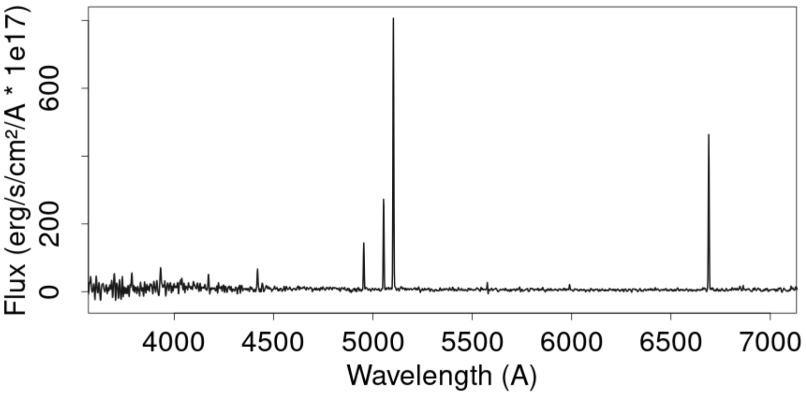

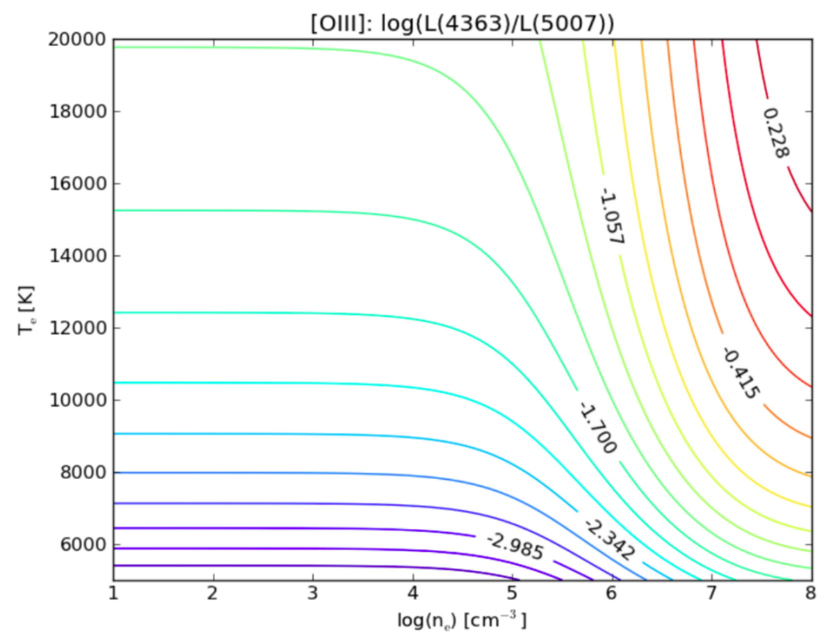

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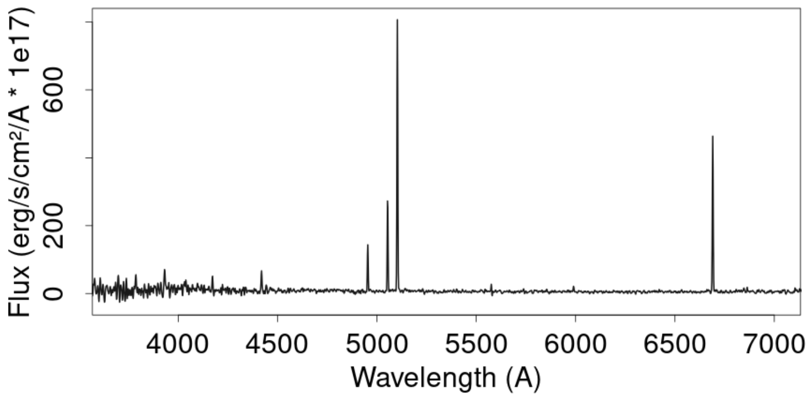

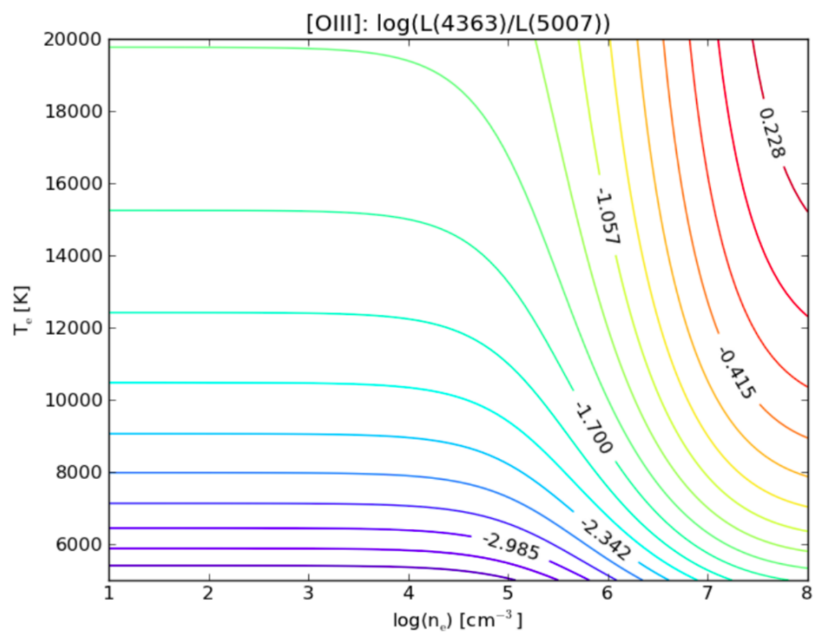

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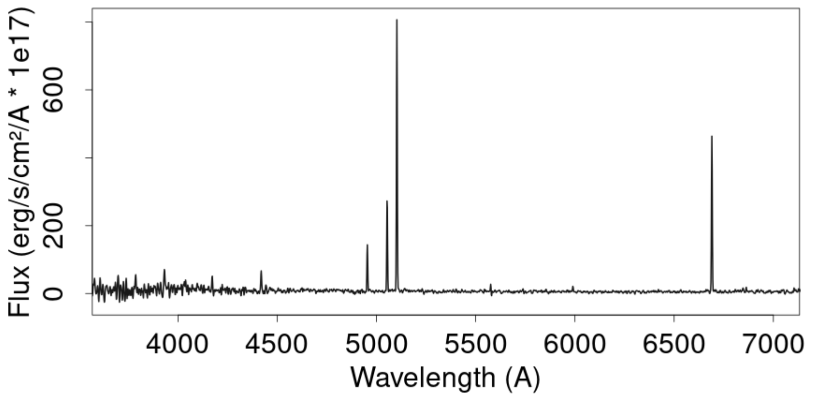
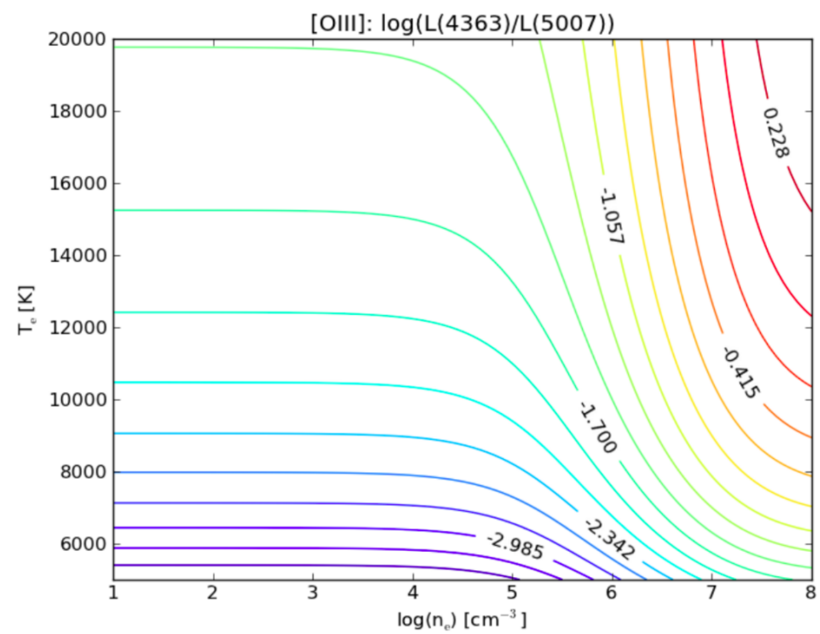
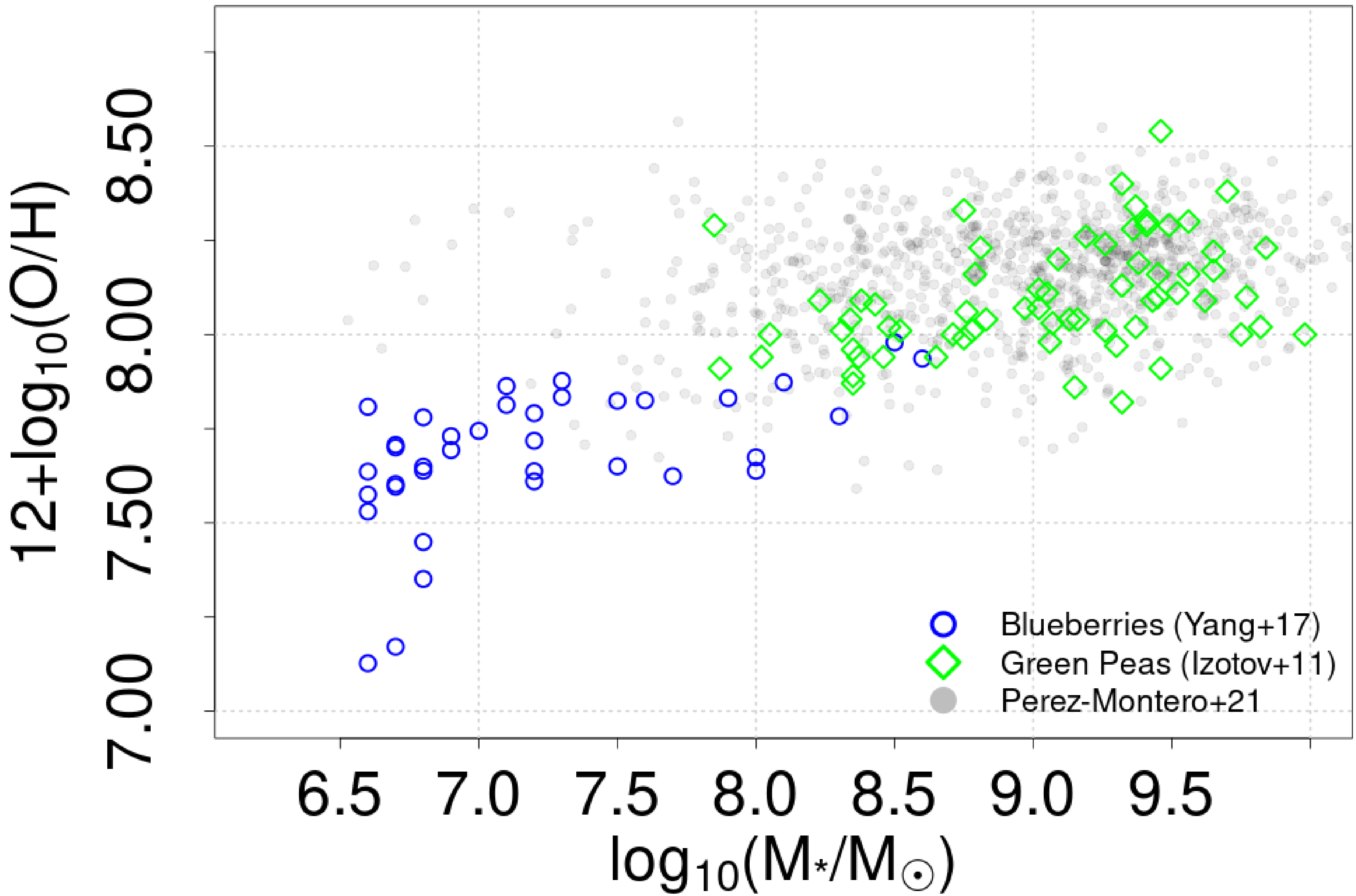




Mass – metallicity relation



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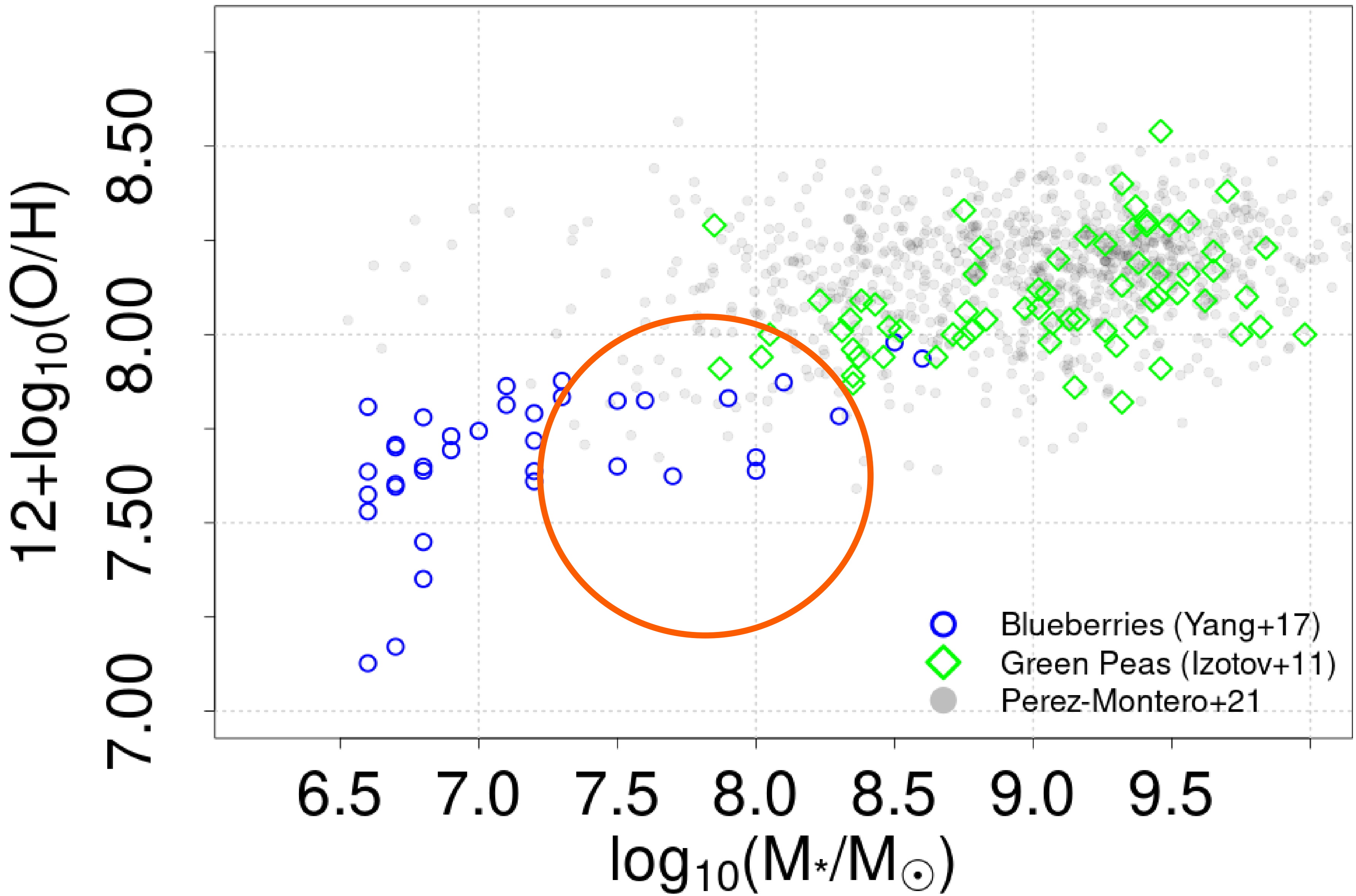

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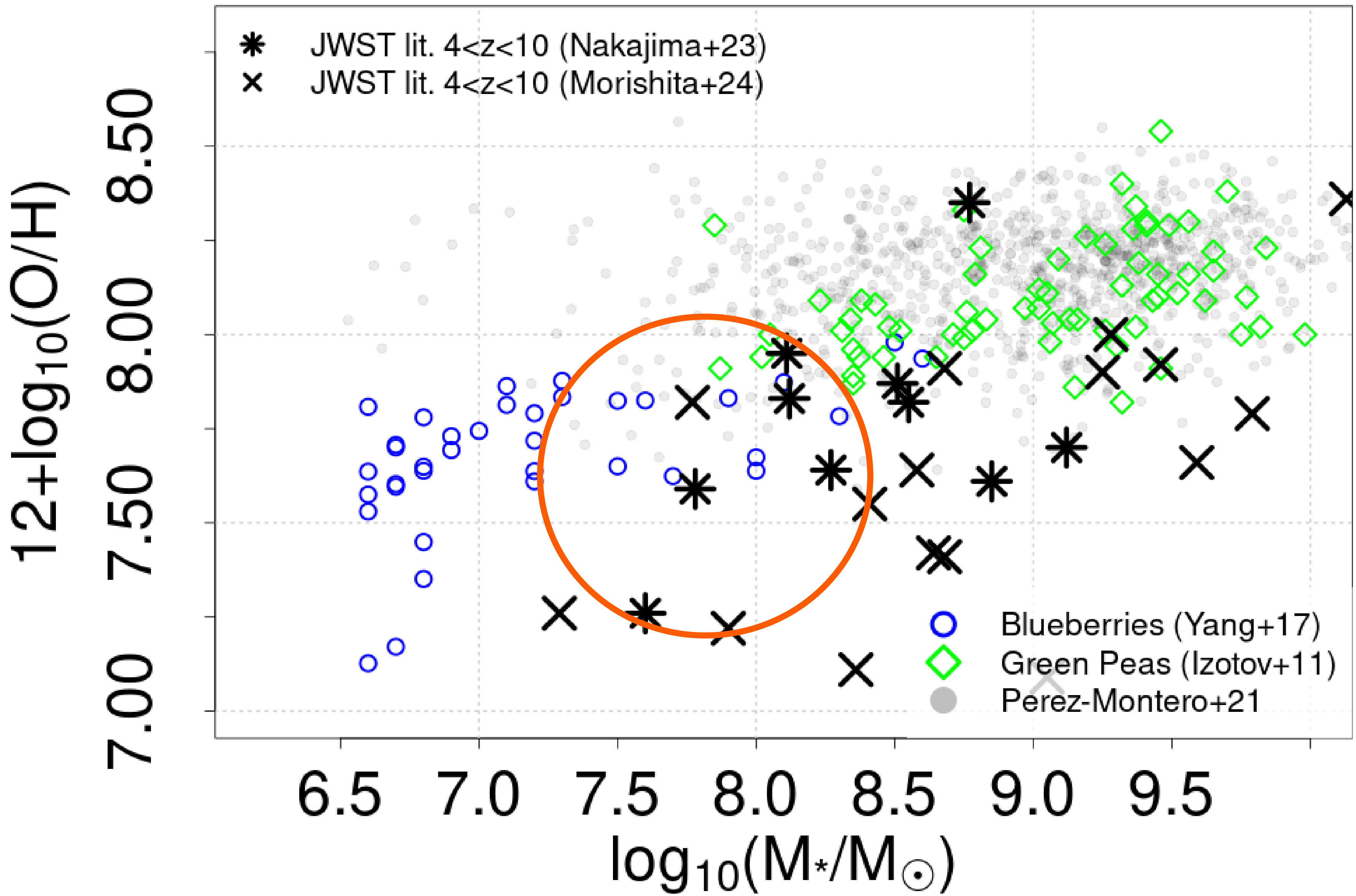

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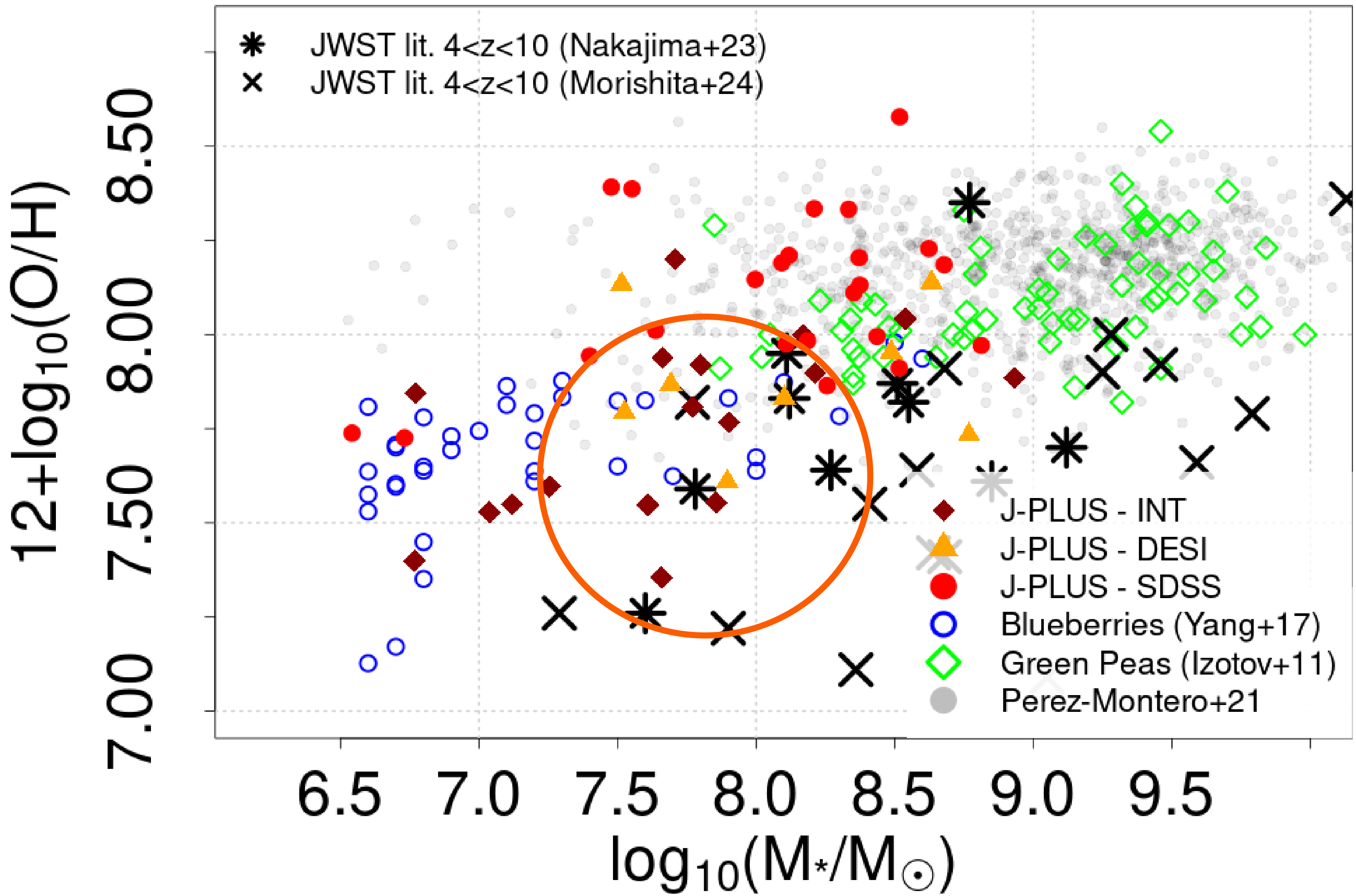

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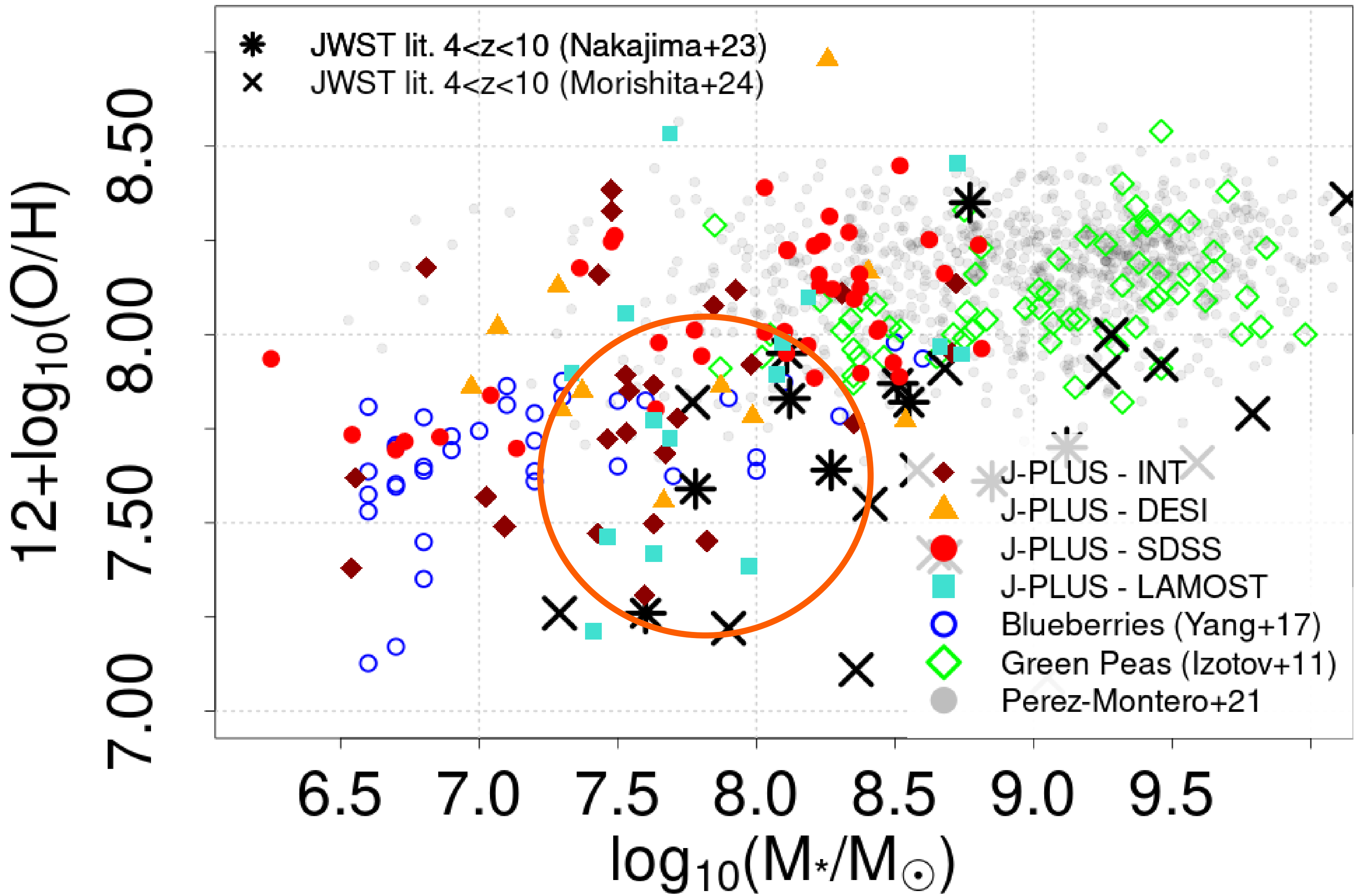
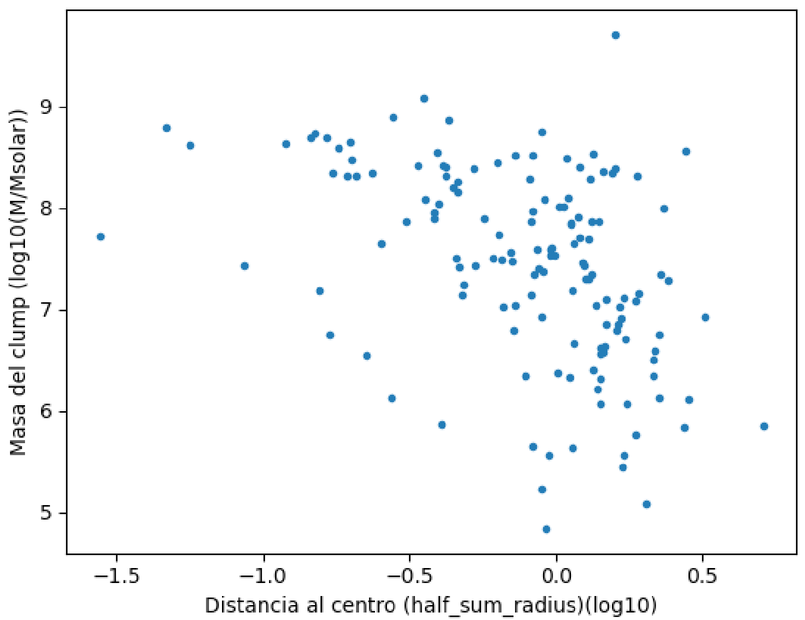
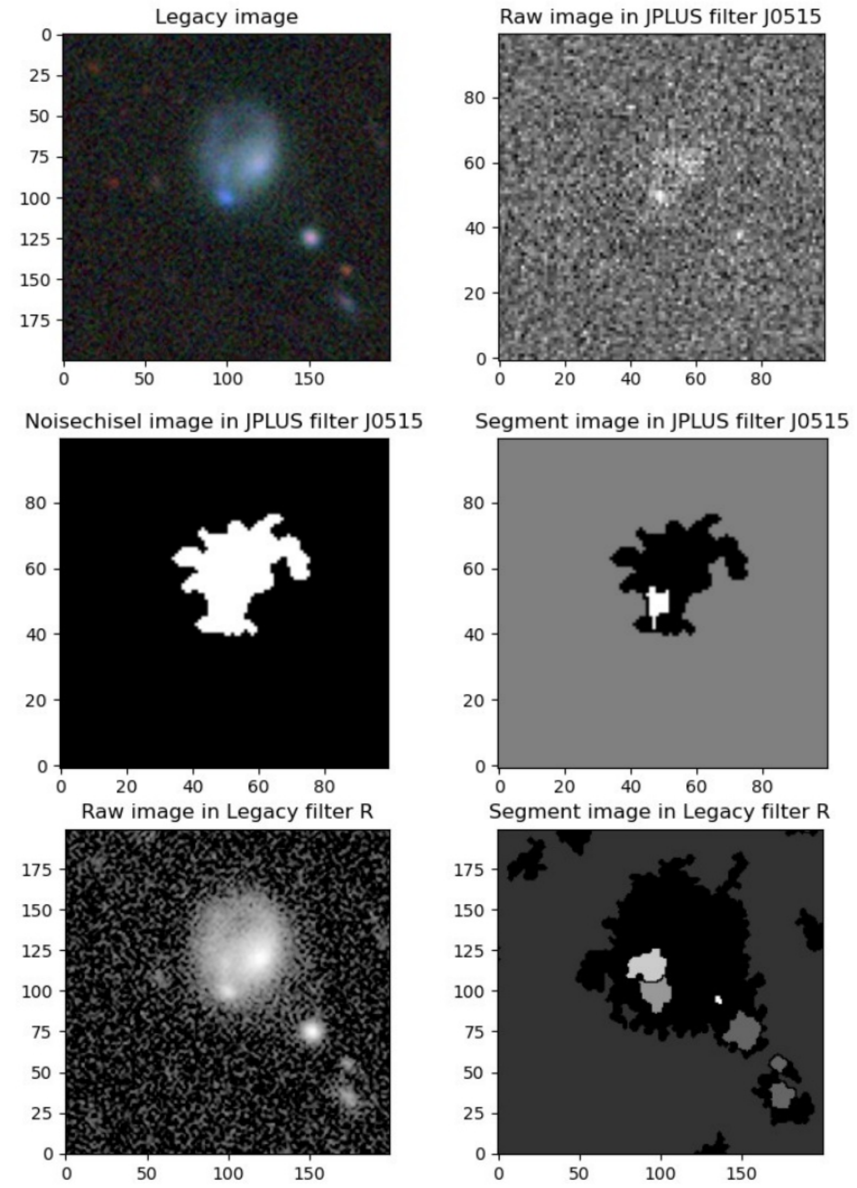


Further analysis of J-PLUS EELGs

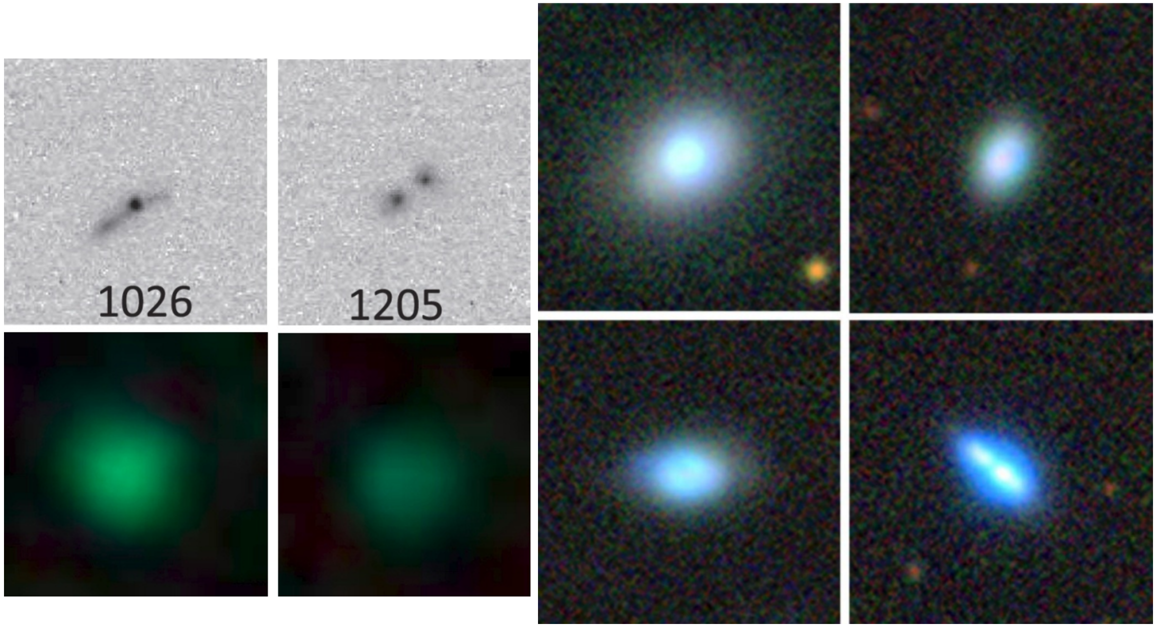
- **Jorge Porrón (Unizar) Master Thesis**
- Identify star-forming clumps in extended EELGs using GNUastro
- The narrowband filter in J-PLUS is just as good (even better) than deeper, higher resolution broadband data identifying clumps
- The farther from the center of the galaxy, the smaller/less massive the clump





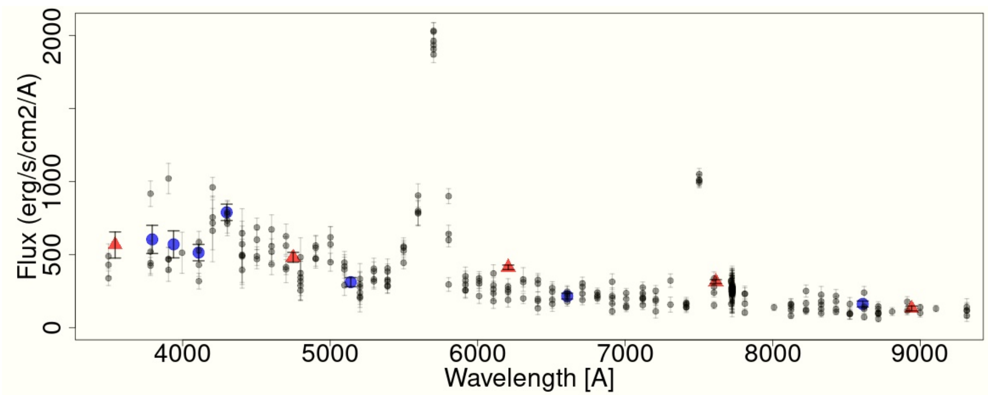
Chandra and HST observations

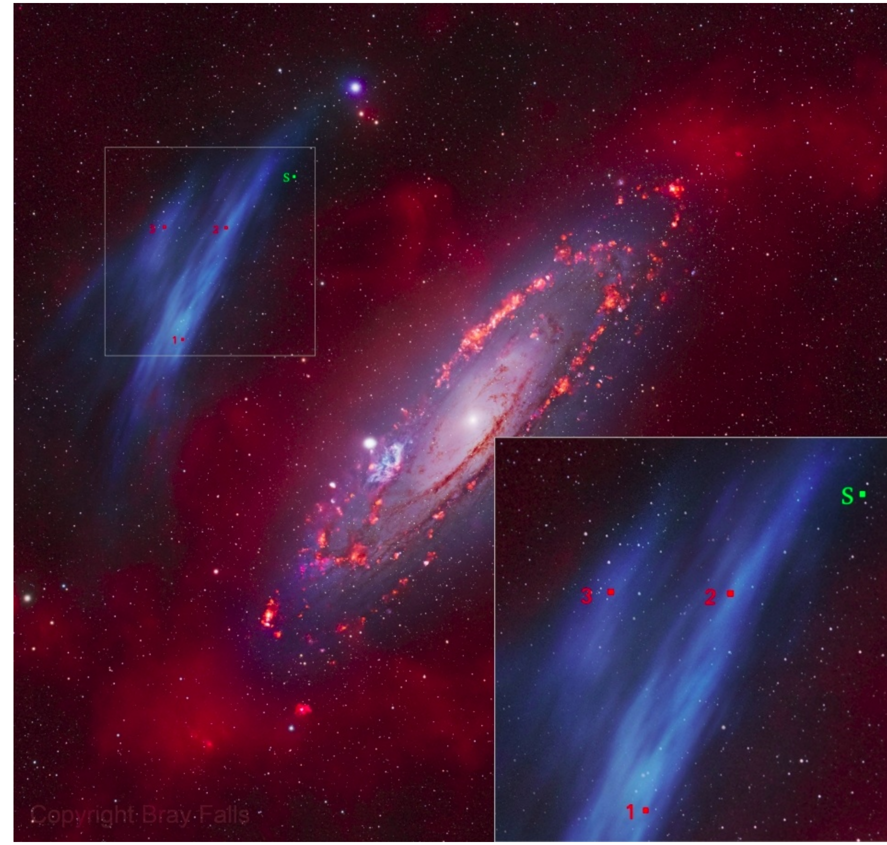
- Accepted Chandra observations (X-Ray)
  - **Do EELGs produce more X-ray binaries than expected?**
  - PI J. Irwin (U. of Alabama)
  - 7 galaxies, 156 ksec
  - First two galaxies: NO X-RAY!
    - Perhaps too young to have developed X-ray binaries?
- Joint HST observations accepted for 2024/2025
  - High resolution imaging
    - Unveal the structure of the interstellar medium
  - 7 orbits
  - UV, near-IR and Halpha filters

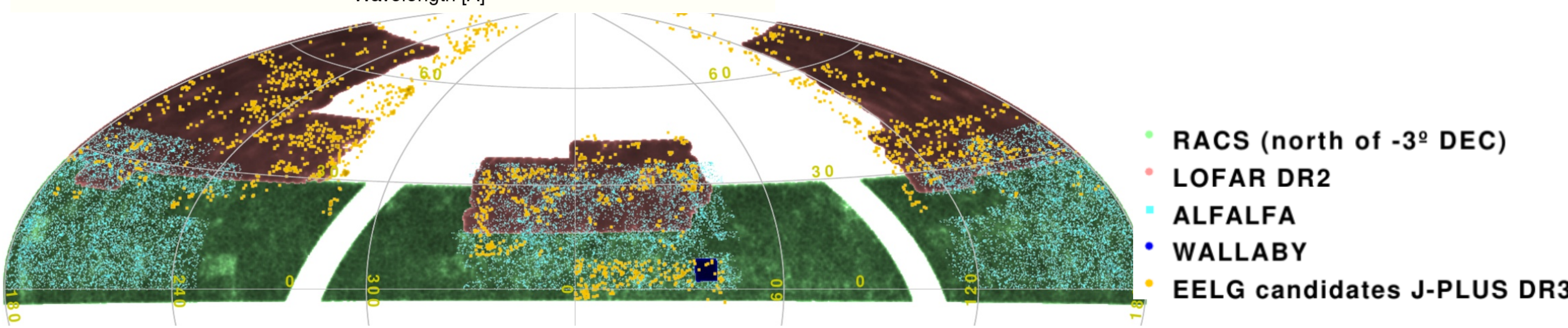


4. Other work

- First tests on JPAS-SV
- SKA precursors-pathfinders (synergy!)
  - HI emission in EELGs
- Out of J-PLUS/J-PAS
  - DESI extreme emitters
  - [OIII] nebula near M31







Summary

- Finalizing the selection of extreme emission line galaxies in J-PLUS
  - Identifying new sample (iSDSS selection, filling the gap)
  - Polishing the selections (BANNJOS galaxy-QSO separation, variation of filter transmission curves)
- In depth analysis of detected EELGs
  - Spectroscopic follow-up:
    - Analizing the emission line and deriving physical properties: similar metallicity as the most distant galaxies
    - Performing and securing more observations (GTC, WEAVE)
  - Morphological analysis, finding clumps (TFM J. Porrón)
  - Securing X-Ray (Chandra) and high resolution follow-ups (Hubble)
  - SKA: Radio detections of neutral hydrogen in EELGs, fueling the star formation
- Other work aqonutug
  - OAJ surveys: First tests with JPAS-SV data
  - Other: DESI spectra // [OIII] nebula near M31