# Complex Lyα profiles in UV-bright galaxies:

## outflowing / inflowing gas and high LyC leakage


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OBSERVATOIRE DE GENÈVE FONDÉ EN 1772


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# Why we should care about UV-bright star-forming galaxies?

- massive star-formation … thus **high LyC production**

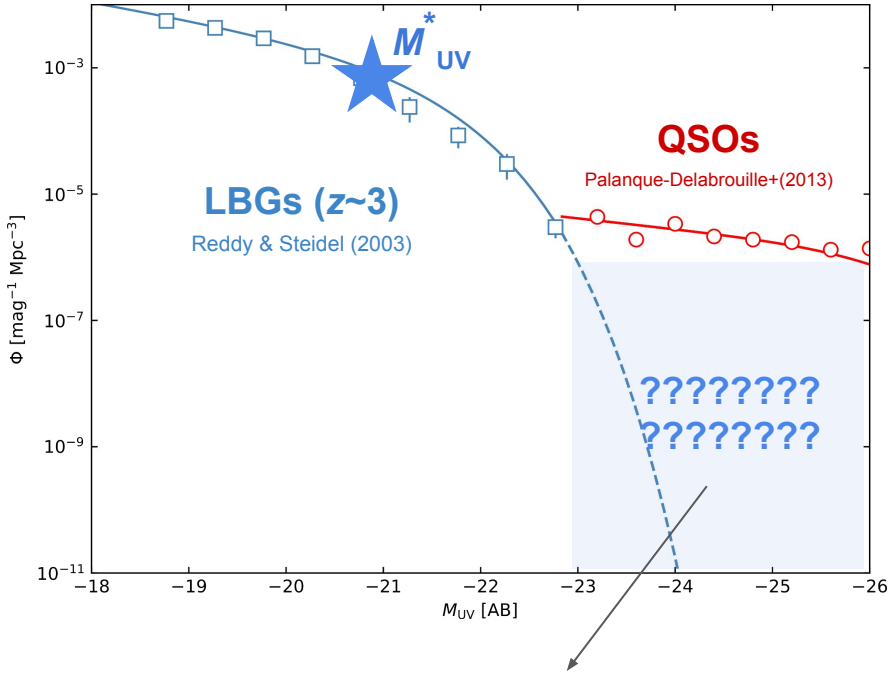
  **what about the escape of LyC photons??**

- excess of UV-bright EoR sources uncovered by JWST/HST:
  - more than predicted by models
  - contribution to cosmic reionization?
  - higher SF efficiency ? Dust ejected ? Top-heavy IMF ?

  (Dekel+23, Ferrara+23, Fiore+23, Kannan+23, etc.)

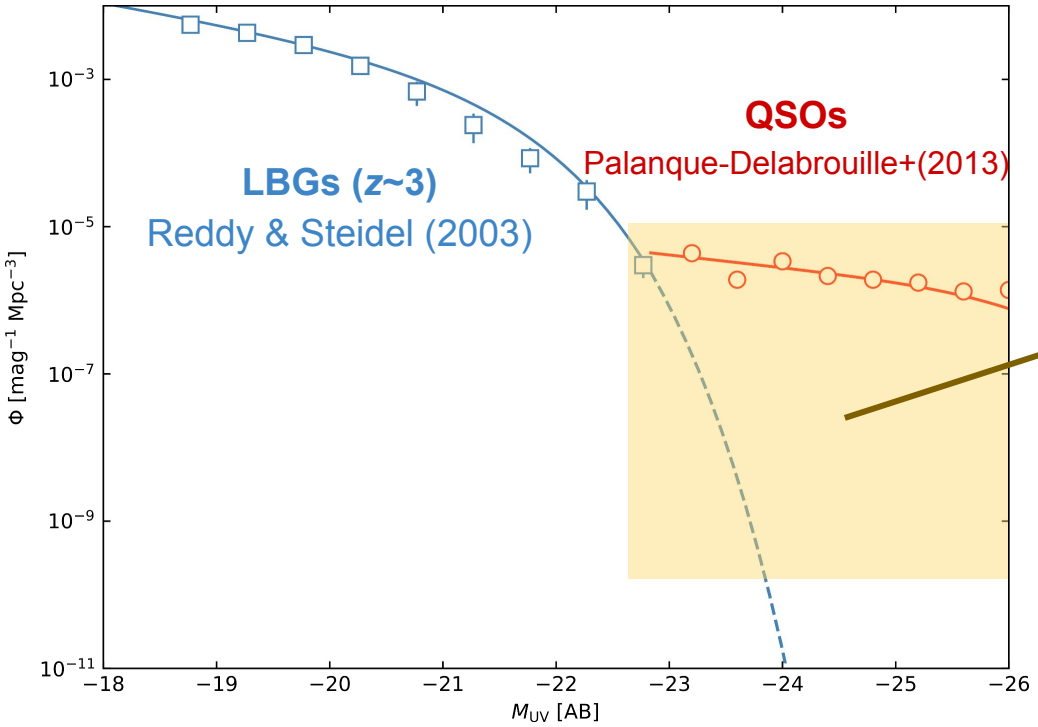
- We know little/nothing about their properties

  (formation? nature? LyC properties? etc.)




**Need of large area surveys**

# An unorthodox but efficient way to search for UV-bright SF galaxies




## This project/talk:

**UV-bright star-forming galaxies at z>2**

within the 9,000 deg$^2$-wide BOSS/SDSS

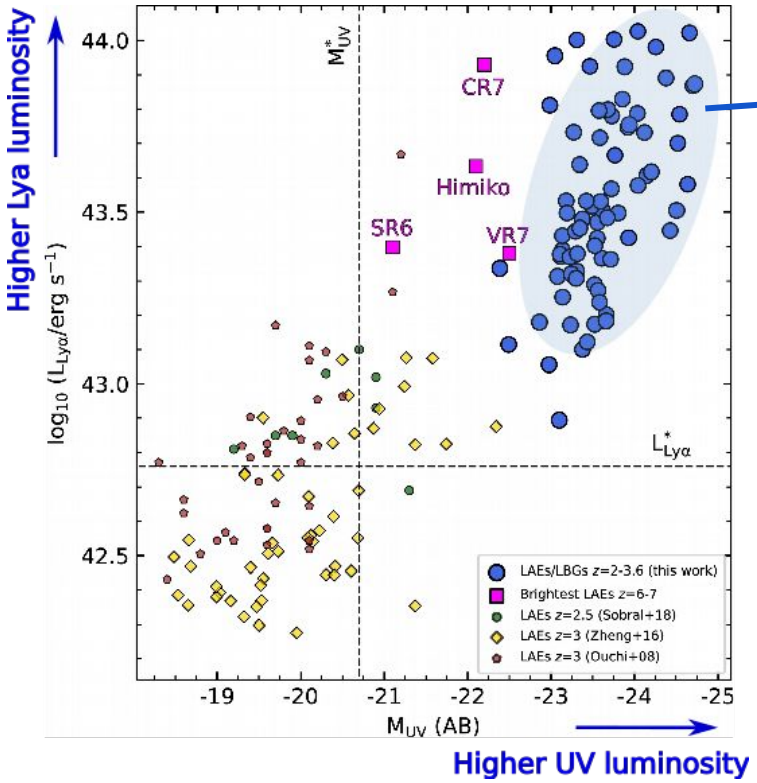
Probing an unexplored range of $M_{UV}$

*caveat:* *BOSS selects bright QSOs at z>2,* ***not star-forming galaxies***

*completeness is not known/difficult*

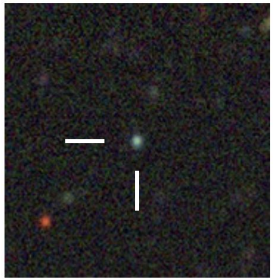
# The most UV and Lyα luminous star-forming galaxies known

**Marques-Chaves + (in prep.)**

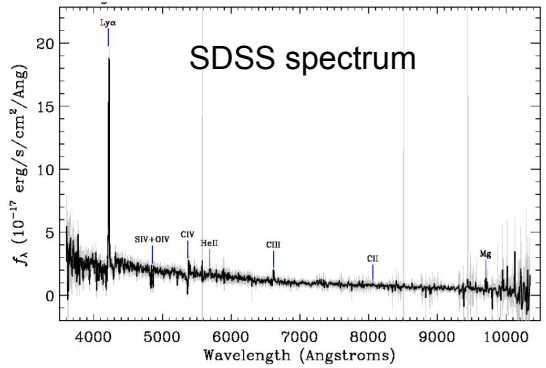



**New sample of ~80 UV-luminous SFGs at *z* = 2 - 3.6**

- Selected within the BOSS/SDSS survey as QSOs
- Bright apparent magnitudes R ~ 21 AB (UV rest-frame)
- But no evidence of AGN activity nor lensing



Compact morphologies



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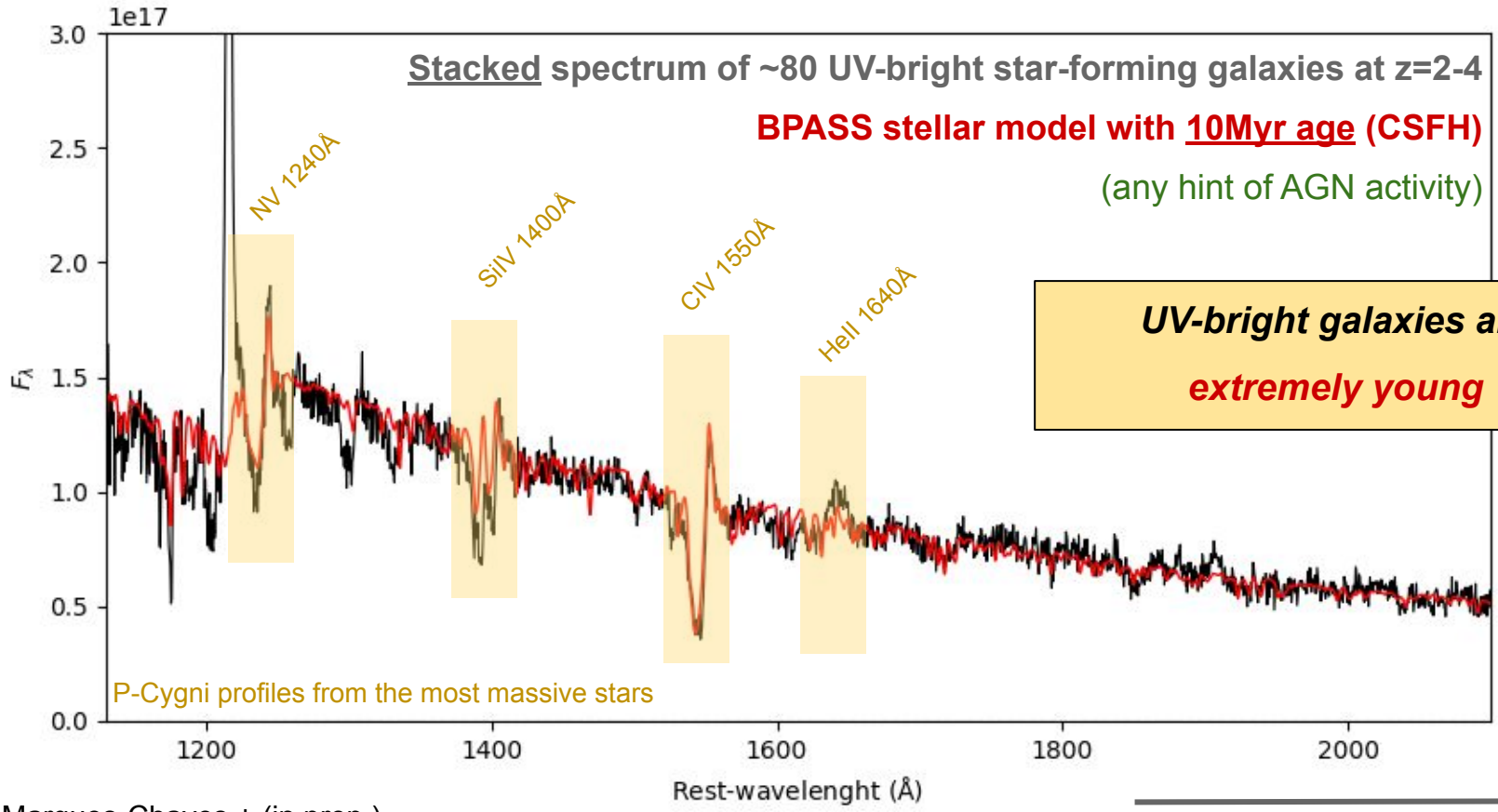


***UV-bright galaxies are extremely young***

Marques-Chaves + (in prep.)

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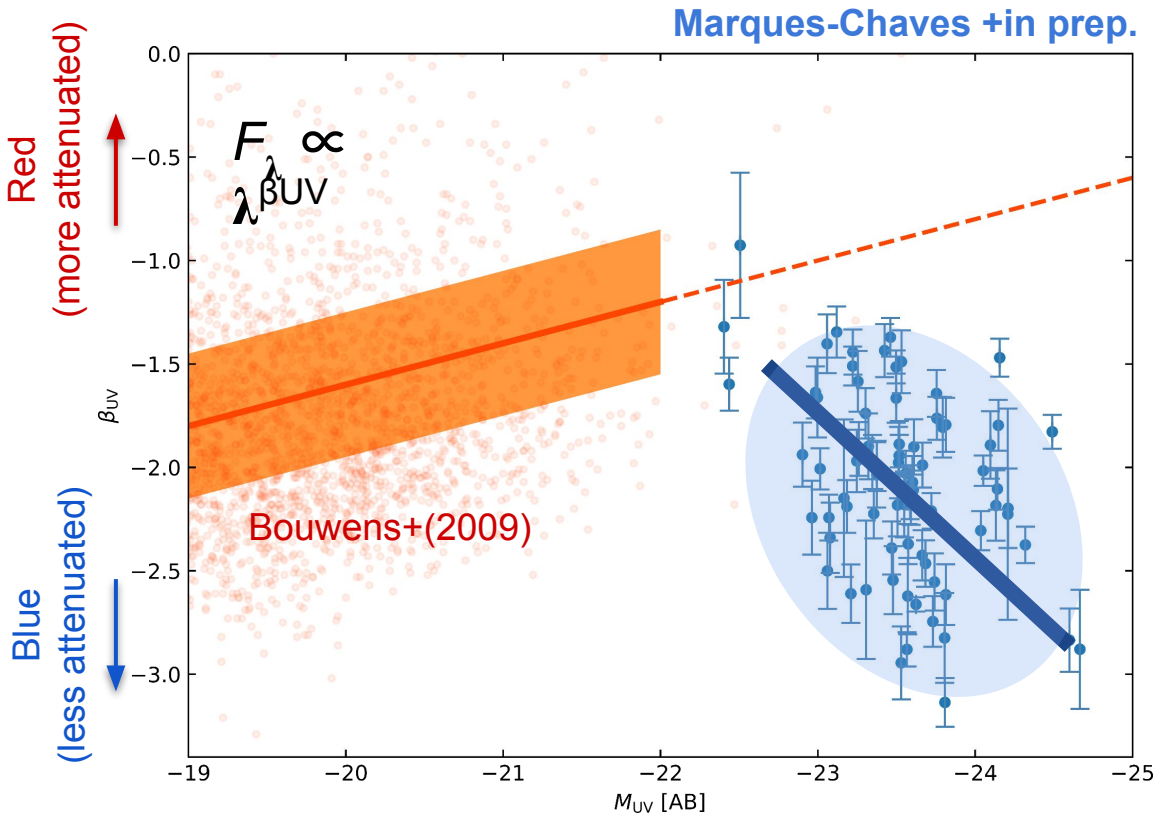
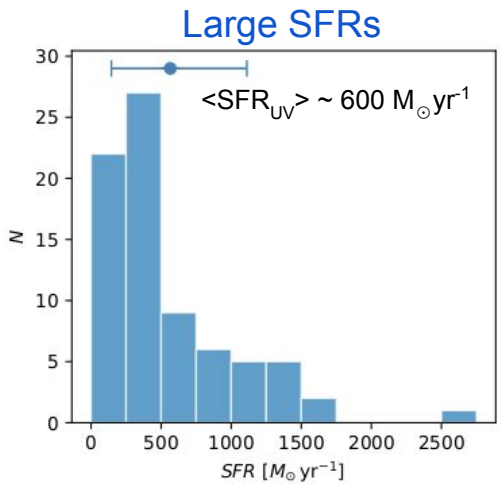
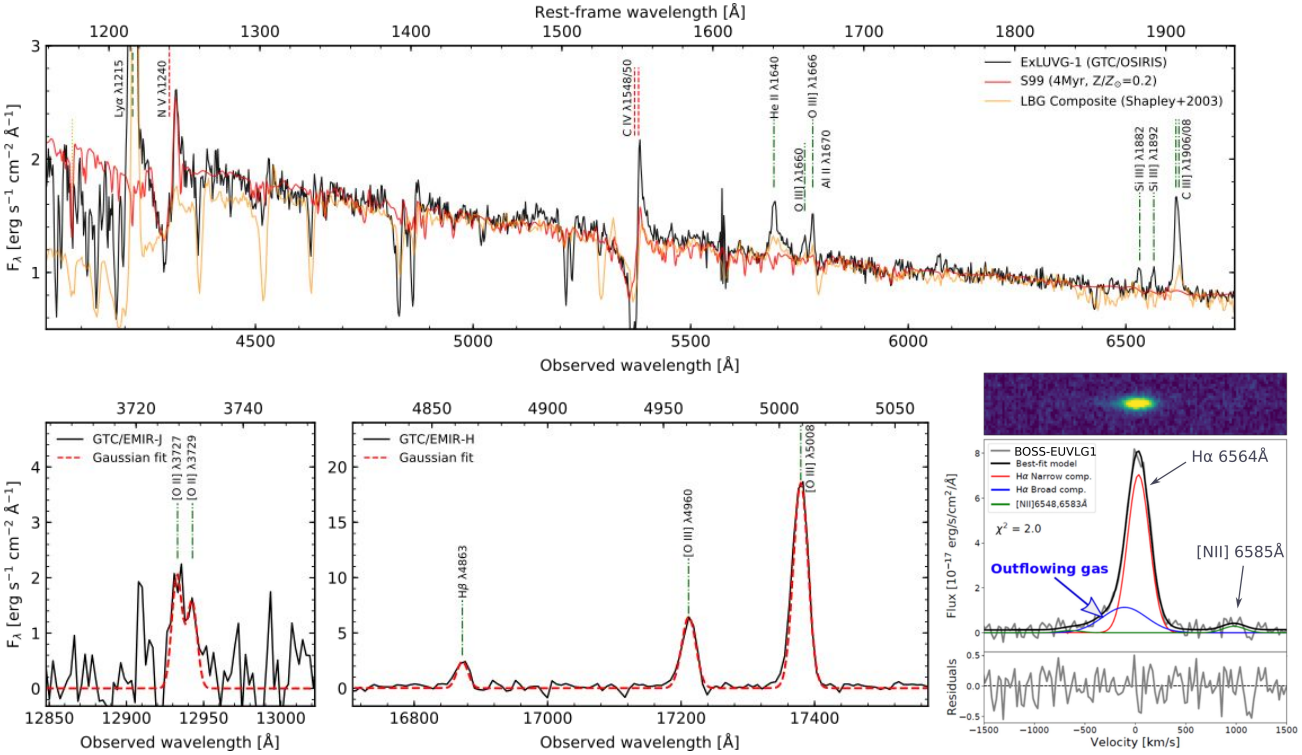



***UV-bright galaxies are BLUE***

# A dust- and metal-poor starburst with QSO-like luminosity

**BOSS-EUVLG1 at z=2.47 (J1220+0842)**
(Marques-Chaves+2020)




- **$M_{UV}$ = -24.40 (AB)**
- Young stellar pop. = 4Myr
- **SFR = 1060 ± 100 $M_\odot yr^{-1}$**
- sSFR = 100 $Gyr^{-1}$
- **12+log(O/H) = 8.13 ± 0.19**
- [OIII]/[OII] = 20
- **E(B-V) = 0.04**
- **$\log(L_{IR} / L_{UV}) < -1.2$**

Ionized outflow
(Alvarez-Marquez +2021)

# A dust- and metal-poor starburst with QSO-like luminosity

**BOSS-EUVLG1 at z=2.47 (J1220+0842)**
(Marques-Chaves+2020)

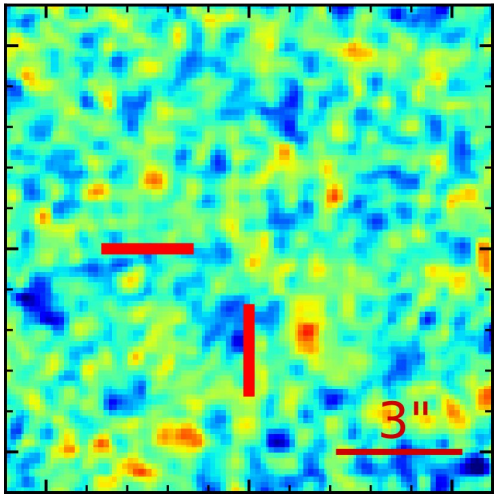
**Dust emission is not detected**

ejected by winds/SNe?

<u>or</u>

not formed yet in large amounts?

ALMA 1.2mm

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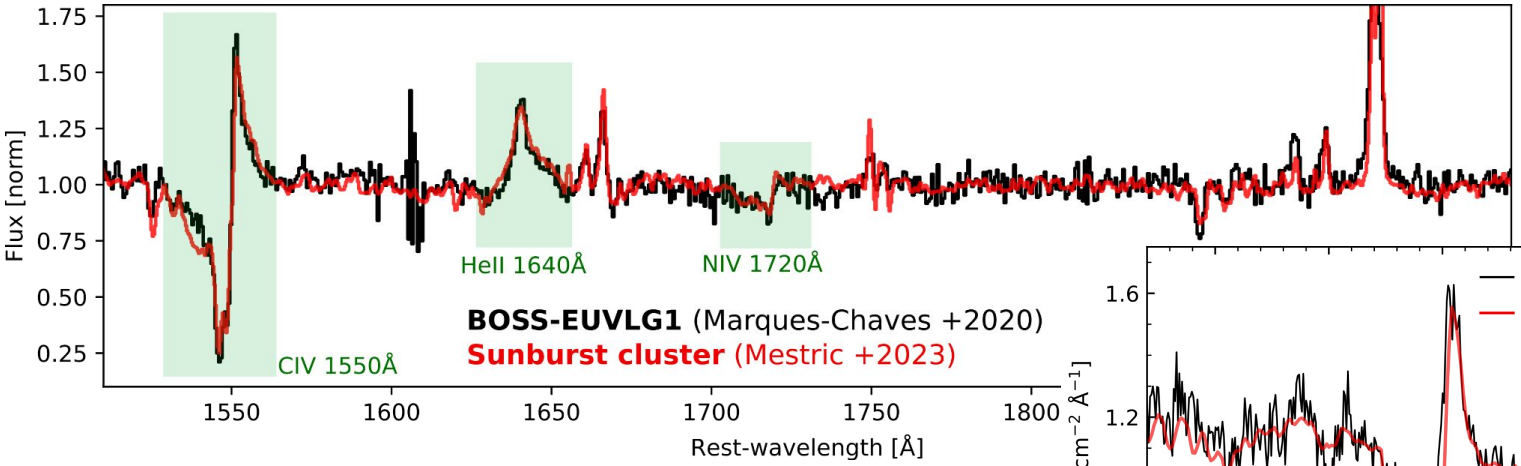
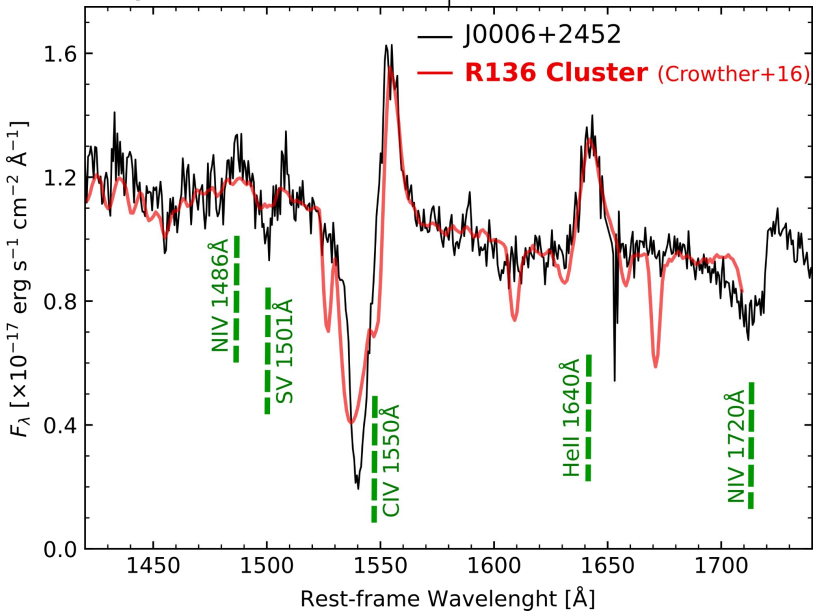
- **$\log(L_{IR} / L_{UV}) < -1.2$**
- **$M_{dust} / M_\odot < 1.9 \times 10^7$ (3σ)**

# UV-bright galaxies as super star-clusters? How?




Upadhyaya et al.
in prep.

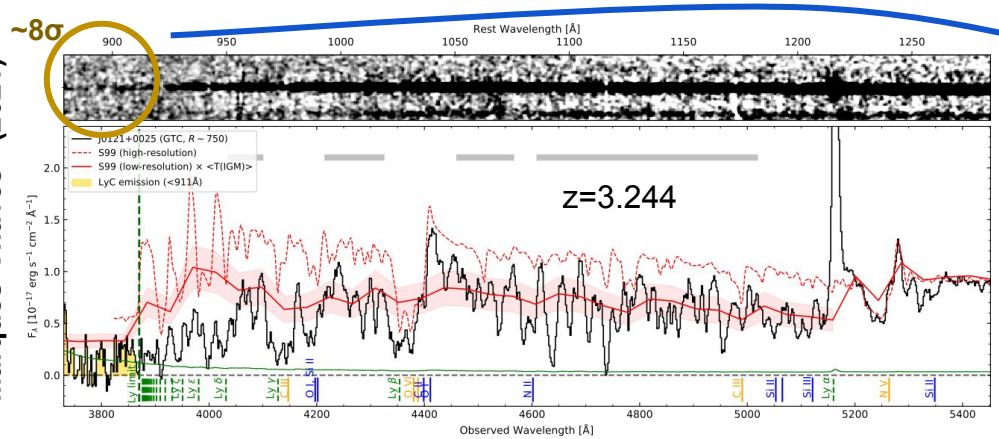



*Spectra of UV-bright sources ($M_{UV}$ ~ -24)*
*resemble those of young star-clusters (1-2 Myr)*
*with $10^5$ - $10^7$ $M_\odot$ with **VMS** (top-heavy IMF ?)*

(see F. Martins's and U. Mestric's talks)

# UV-bright galaxies are strong LyC emitters

Marques-Chaves +(2021)

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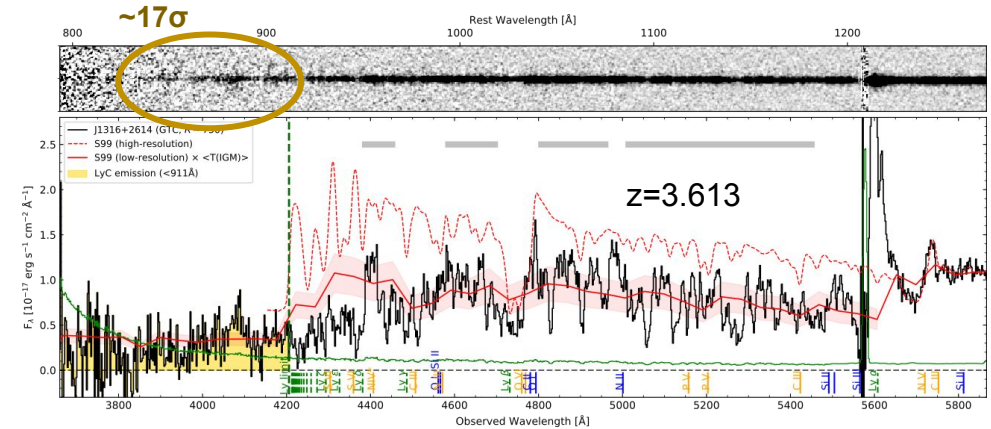
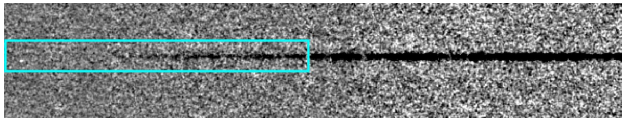



New observations



**Detection of Lyman continuum (LyC) emission** with high significance

LyC: $\lambda_0$ < 912 Å or > 13.6 eV

**LyC escape fractions of ~ 40% to 90% !**

(absolute)

**(record-holder)**

***UV-bright galaxies are strong LyC emitters***

# Lyman-alpha profiles of UV-bright star-forming galaxies

**BOSS-EUVLG1:**
z = 2.469
$M_{UV}$ = -24.40
EW(Lyα) = 22 ± 3 [Å]
log(Lyα) = 44.0 [erg/s]
$f_{esc}$(Lyα) = 10 %
**$f_{esc}$(LyC) not known**

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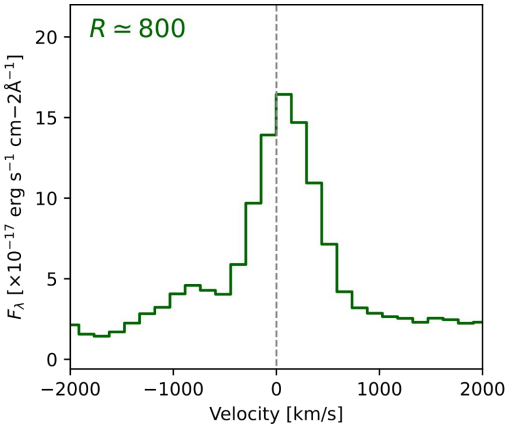


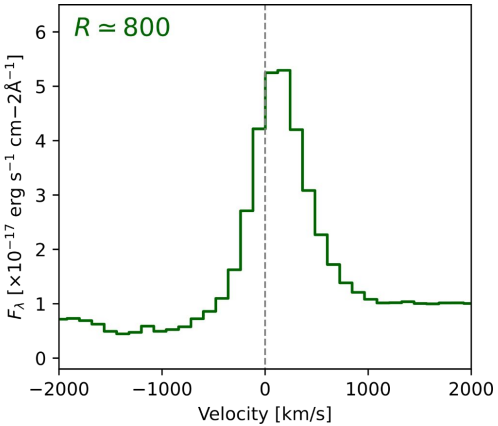


**J0121+0025:**
z = 3.244
$M_{UV}$ = -24.11
EW(Lyα) = 14 ± 3 [Å]
log(Lyα) = 43.8 [erg/s]
$f_{esc}$(Lyα) = 14 %
**$f_{esc}$(LyC) = 40 %**

Marques-Chaves +2021

**J1316+2614:**
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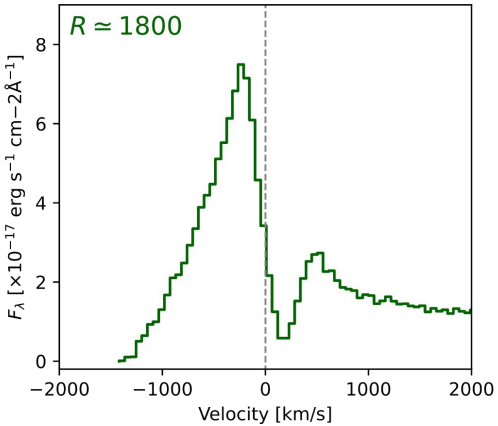


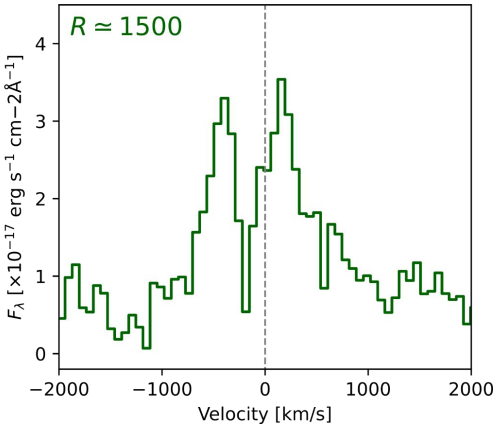


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Leclercq + (in prep.)

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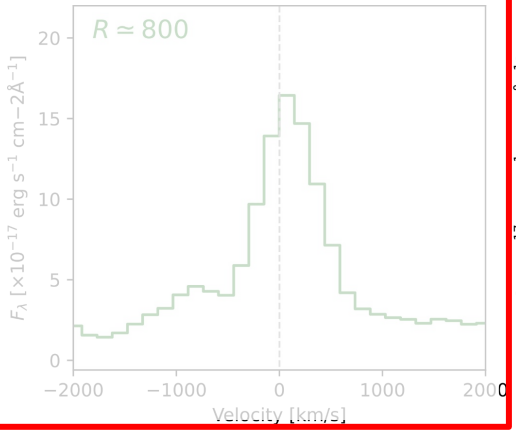


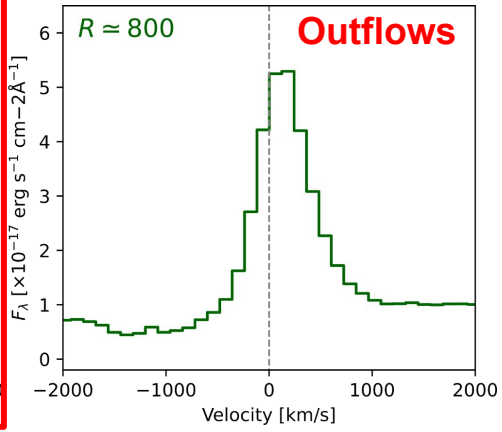


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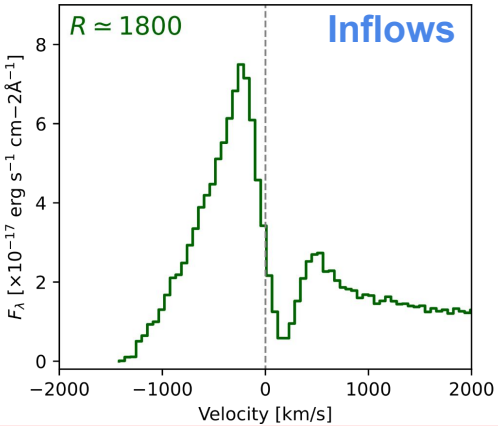


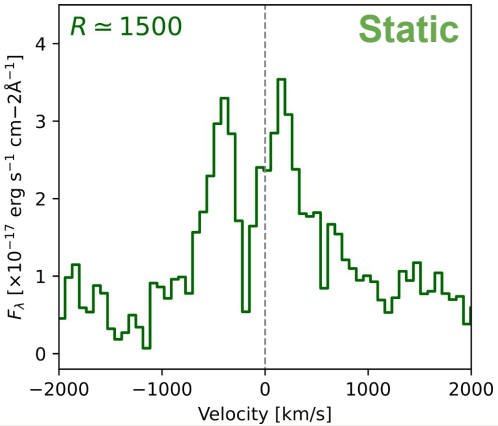


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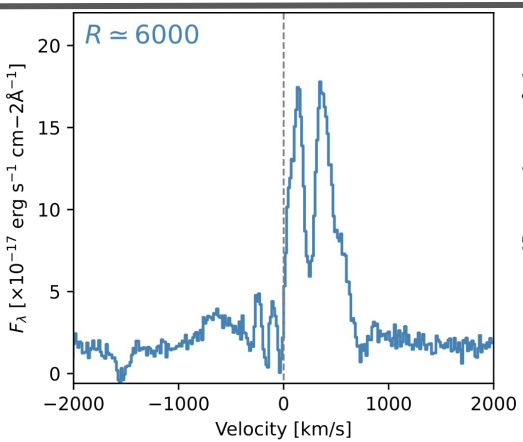


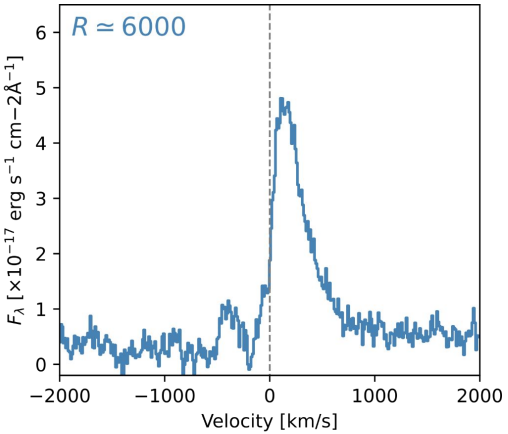


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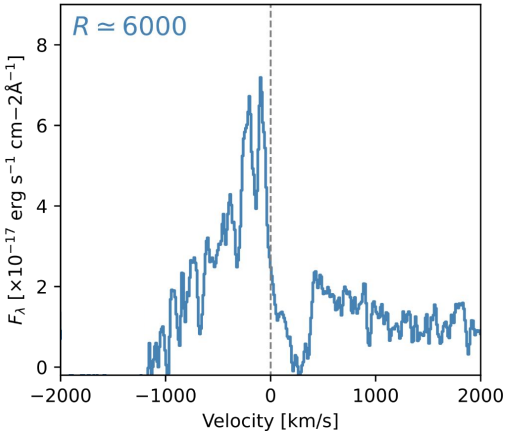


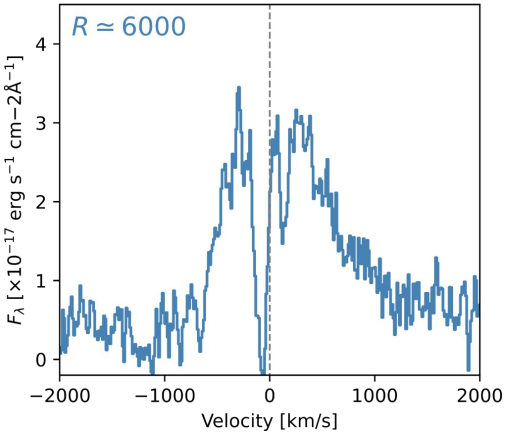


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Leclercq + (in prep.)

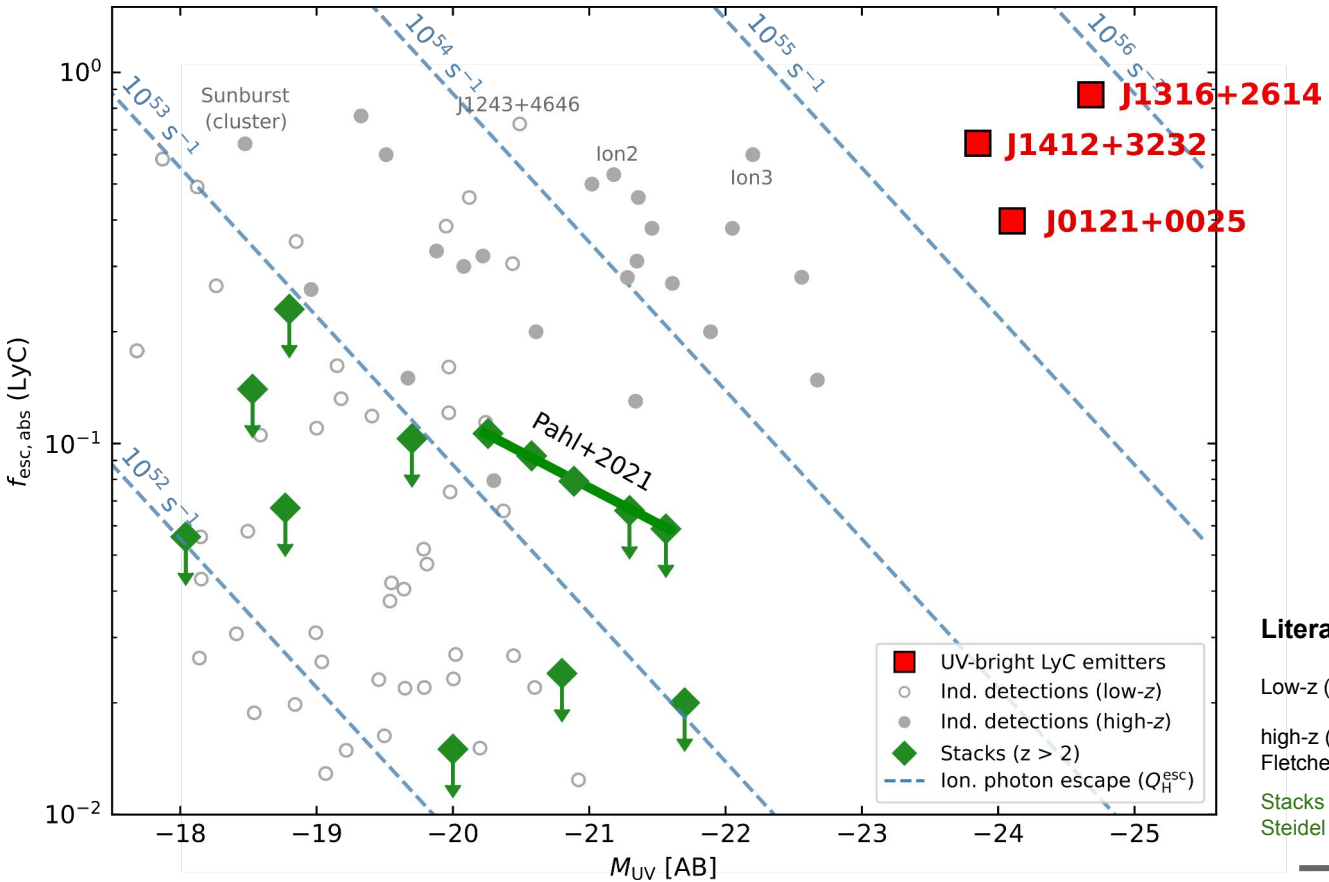
# Indirect LyC indicators: do they work on UV-bright LyC emitters?

From previous works/samples we know that faint/normal LyC emitters show:

| "Normal" LyC emitters | UV-bright LyC emitters | Value |
|---|---|---|
| Steep UV slopes | **Yes** | $\beta_{UV}$ = -2.2 to -2.6 |
| Weak LIS abs. | **Yes** | weak/not detected |
| High sSFR | **Yes** | ~ 100 $Gyr^{-1}$ |
| High ΣSFR | **Yes** | > 10-150 $M_{\odot} yr^{-1} kpc^{-2}$ |
| Small $\Delta_{sep}$ (Lyα) | **No** | ~ 500-700 km $s^{-1}$ |
| Strong neb. emission | **Not extreme** | EW(Lyα) ~ 10-20 Å<br>EW(Hβ + [OIII]) ~ 250 Å |
| High O32 = [OIII]/[OII] | **Not extreme** | O32 ~ 5-9 |

**All related to nebular emission**

# UV-bright SFGs: the most efficient ionizing sources known




**Literature sample:**

Low-z (z~0.3): Izotov +2016a,b, 2018ab; Flury +2022ab

high-z (z~2-4): Vanzella +2016, 2018, 2020; Shapley +2016; Fletcher +2019; Saxena +2022, Rivera-Thorsen+2019

Stacks (z~2-4): Grazian +2017; Marchi +2017; Rutkowski +2017; Steidel +2016: Fletcher +2019; Bian & Fan 2020; Pahl +2021

From Marques-Chaves+22

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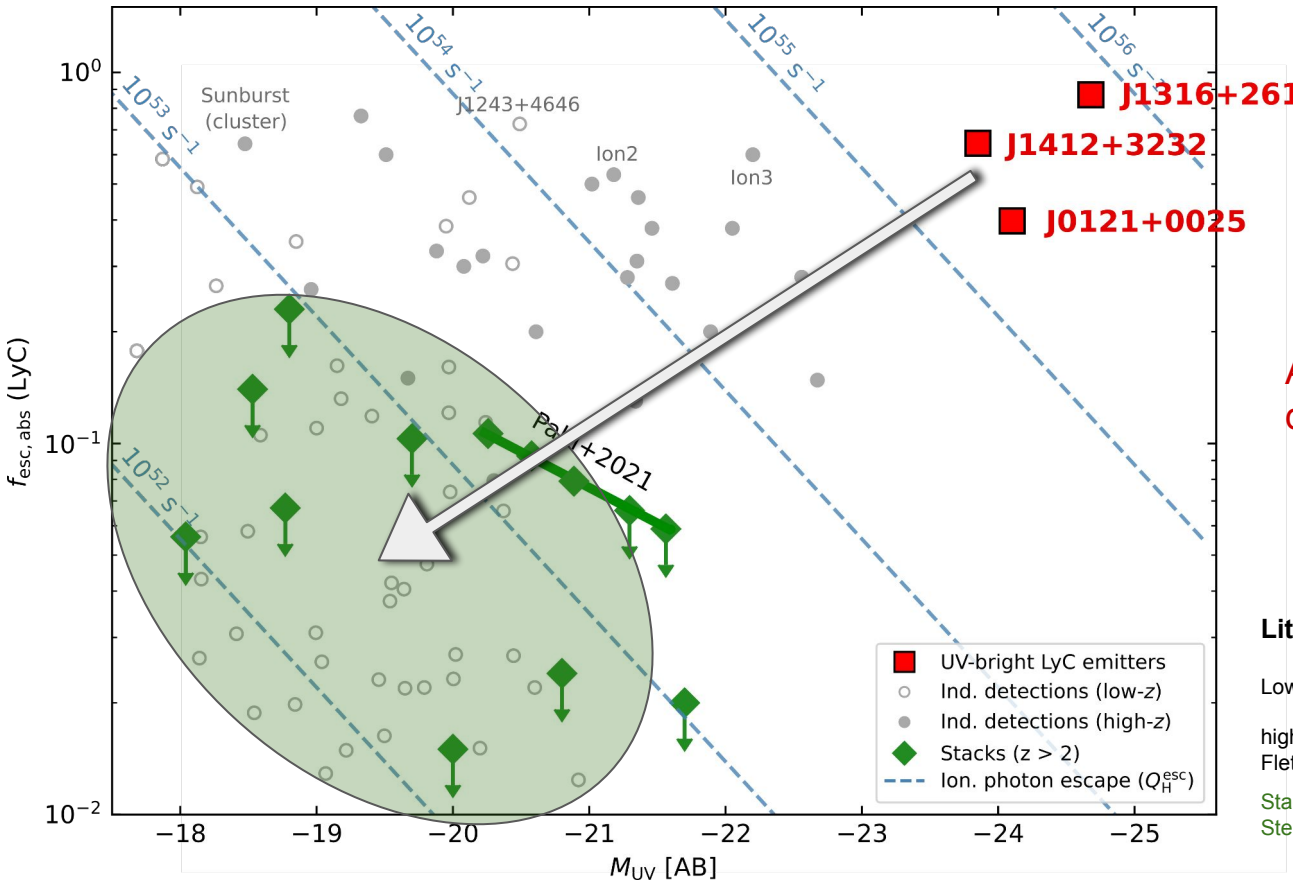


From Marques-Chaves+22

~ $10^3$ - $10^4$ more ionizing photon escaping than in typical/faint SFGs at similar redshifts (stacks)

Are we sure that UV-bright galaxies do not contribute significantly to the cosmic reionization ?

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# Summary

- We have discovered the most luminous star-forming galaxies known in the UV and LyA line

- UV-bright galaxies have extreme properties:

- Extreme stellar populations (young ages with possibly VMS)
- Extreme LyC emission (fesc~40%-90%)
- Complex LyA profiles (~ complex gas kinematics/geometry)

- Many open questions related to their nature, formation and role in galaxy formation & reionization

**thank you!**