Using Lyman-Alpha to detect Lyman Continuum escape from galaxies

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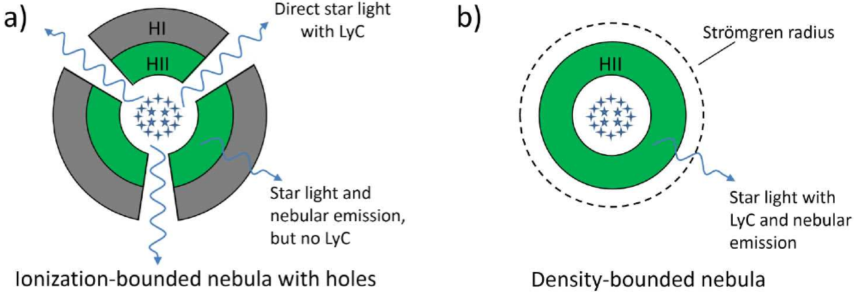
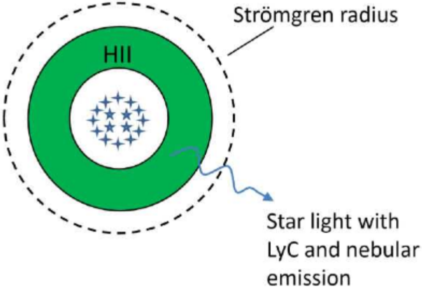
1. Using Lyα to detect Lyman Continuum Emitters
   - LyC leakgage from optically thin H II region
   - LyC leakage from riddled ISM
2. Lyα properties of 5 newly discovered LyC Emitters
   - Description of our 5 LyC emitters
   - Their Lya properties
     - A strong Lyα emission
     - narrow double-peaked profiles

Context : LyC leaking galaxies

Zackrisson+13



LyC leakage from optically thin H II region

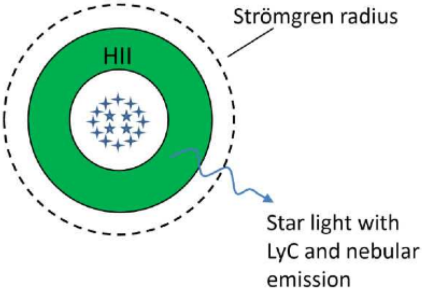


$$f_{\rm esc}(LyC) = e^{-\tau_{\rm ion}}$$
with $\tau_{\rm ion} = \sigma(\nu) N_{\rm HI}$
$$\sigma(\nu) = \sigma_{\nu_0} (\nu/\nu_0)^{-3}$$
$$\sigma_{\nu_0} = 6.3 \times 10^{-18} \text{ cm}^2$$
$$\tau_{\rm ion} = 1 \rightarrow N_{\rm HI} \sim 1.6 \times 10^{17} {\rm cm}^{-2}$$

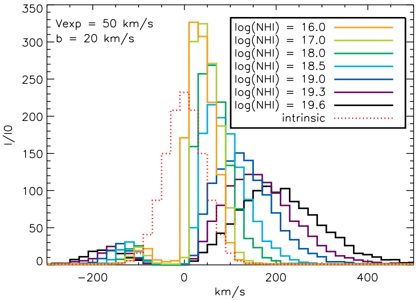
Lyman-alpha optical depth of a LyC optically thin H II region

$$\tau_{\rm ion} = 1 \rightarrow \tau_{\rm Ly\alpha} = 5.88 \times 10^{-14} (12.85/b)\ N_{\rm HI} \sim 10^4$$

LyC leakage from optically thin H II region



Verhamme et al. 2015

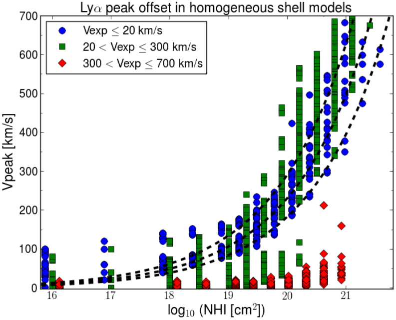


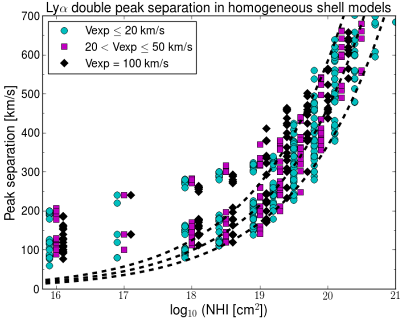
Lyman-alpha spectra from LyC optically thin H II region...

.. are narrow and the location of their peak is close to the line center

LyC leakage from optically thin H II region

Verhamme et al. 2015





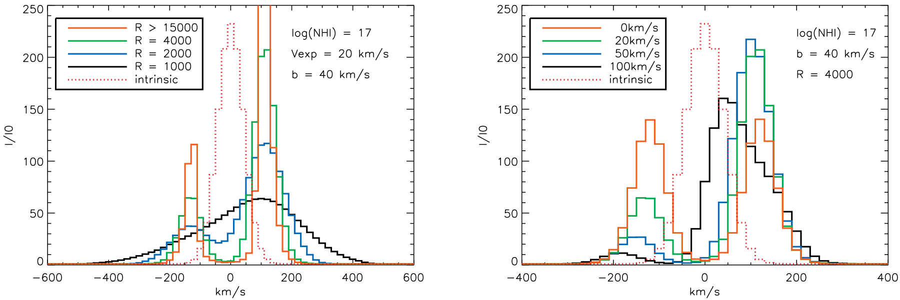
Lyman-alpha spectra from LyC optically thin H II region

Vpeak $\gg$ 150 km.s^{-1} $\rightarrow$ $log(N_{\rm HI}) > 18$

When double peaks, a small peak separation ($<$ 300 km.s^{-1}) indicates a low column density of the neutral gas ($N_{\rm HI} \lesssim 18$).

LyC leakage from optically thin H II region

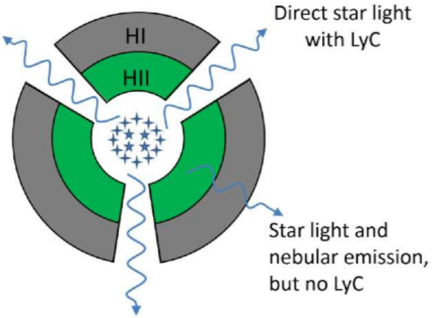
Verhamme et al. 2015



Lyman-alpha spectra from LyC optically thin H II region

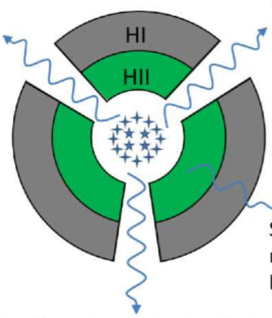
Vpeak measurement is slightly affected by the spectral resolution
Vpeak decreases when Vexp increases.

LyC leakage from riddled ISM



$f_{esc} = 1 - CF$

LyC leakage from riddled ISM



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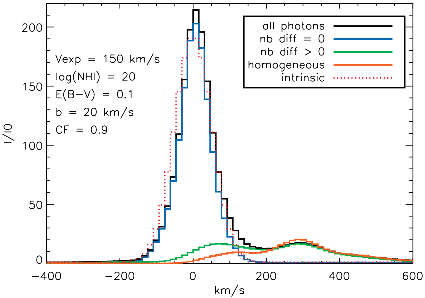
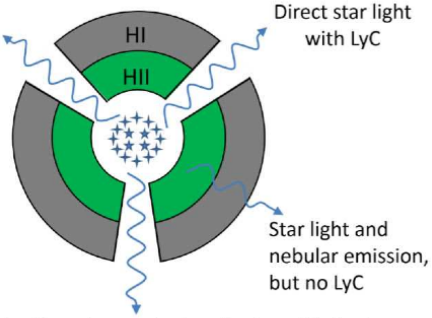


Lyman-alpha spectra from riddled H II region

Whatever the velocity field, the maximum of the profile shifts to the line center, Vpeak = 0 km.s^{-1}.

LyC leakage from riddled ISM



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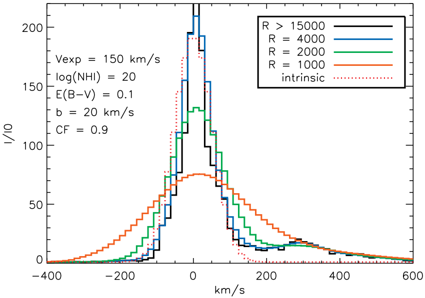

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Plan

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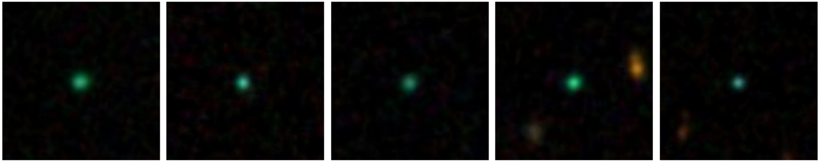
5 newly discovered Lyman Continuum Emitters

Izotov et al. 2016b, MNRAS

Name	z	EW(Hβ) (Å)	12+logO/H	(4959+5007)/3727	*GALEX* FUV flux (erg s^{-1}cm^{-2}Å^{-1})
J0925+1403	0.301	253	7.94	5	2.28e-16
J1152+3400	0.342	168	8.10	8	3.47e-16
J1333+6246	0.318	135	7.81	5	3.27e-16
J1442−0209	0.294	201	7.94	6	4.76e-16
J1503+3644	0.355	238	8.10	7	2.49e-16



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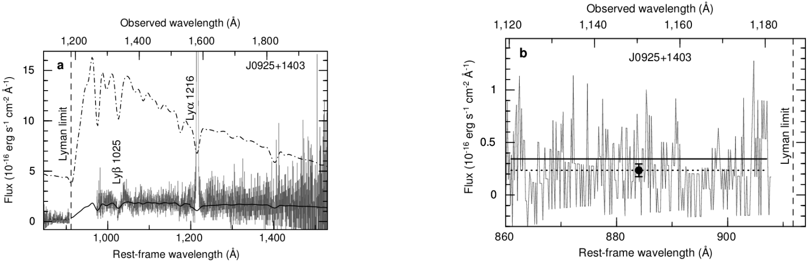
Izotov et al. 2016a, Nature



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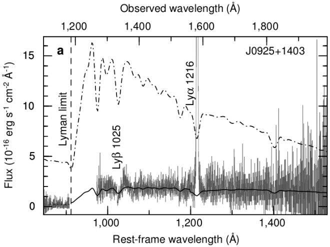
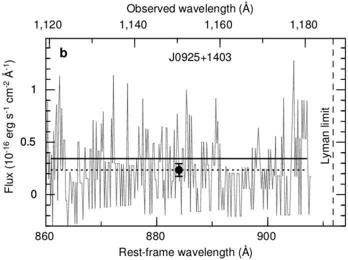
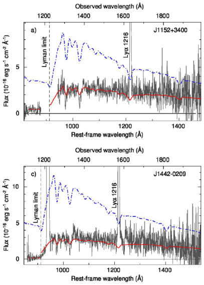


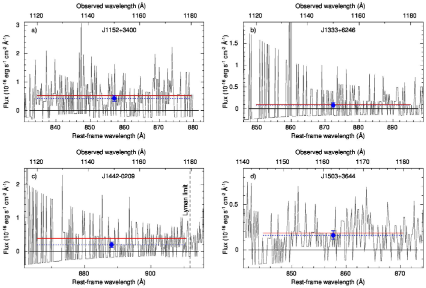


absolute escape fraction of ionising photons fesc $\sim$ 7%

5 newly discovered Lyman Continuum Emitters

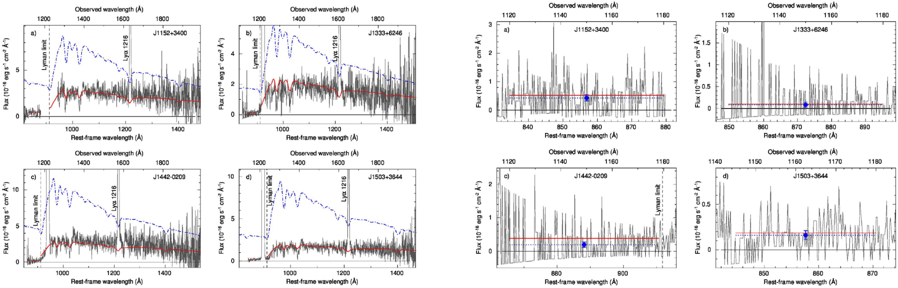
Izotov et al. 2016b, MNRAS





5 newly discovered Lyman Continuum Emitters

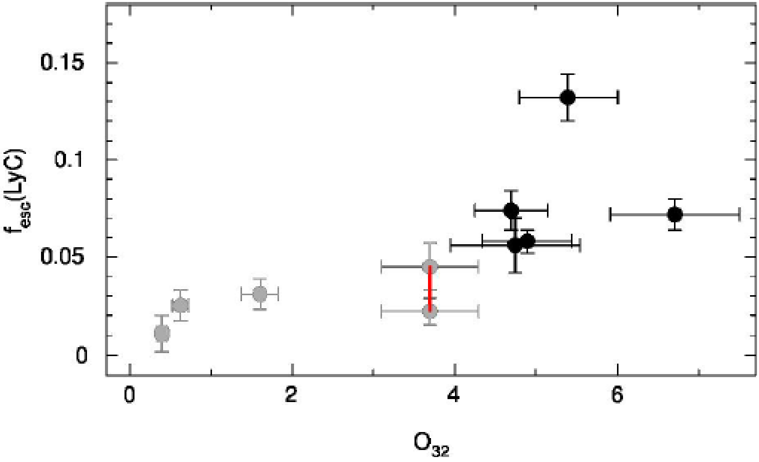
Izotov et al. 2016b, MNRAS



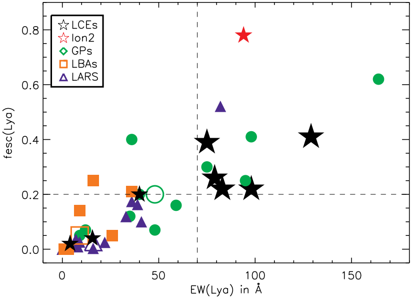
absolute escape fraction of ionising photons fesc $\sim$ 6 to 13%

5 newly discovered Lyman Continuum Emitters

Izotov et al. 2016b, MNRAS



LCEs are strong Lyman Alpha emitters



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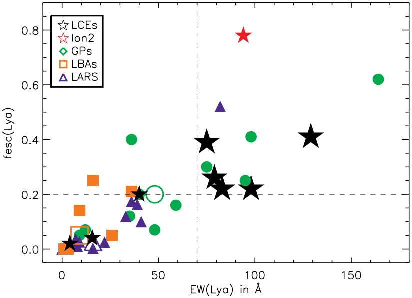
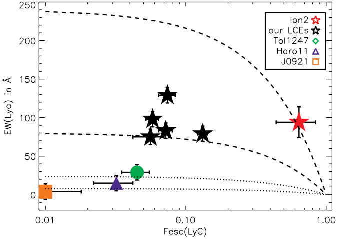
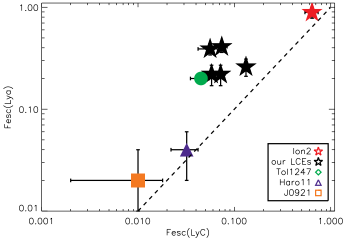
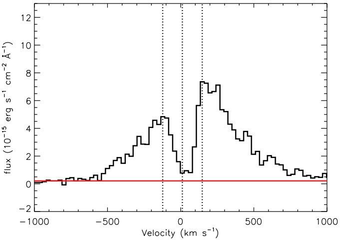




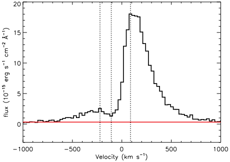


LCEs have narrow double-peaked profiles

fesc(LyC)=0.132



fesc(LyC)=0.074



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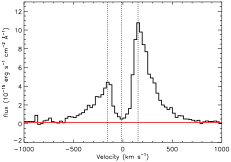
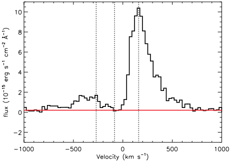


fesc(LyC)=0.058



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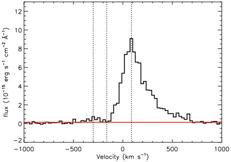
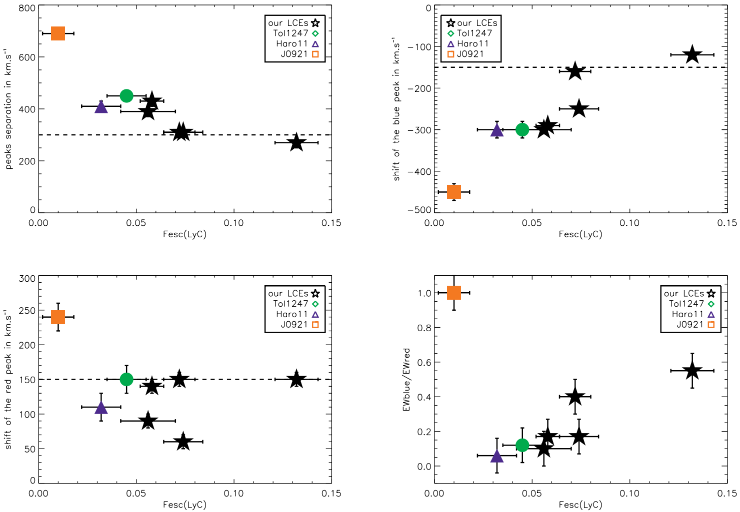
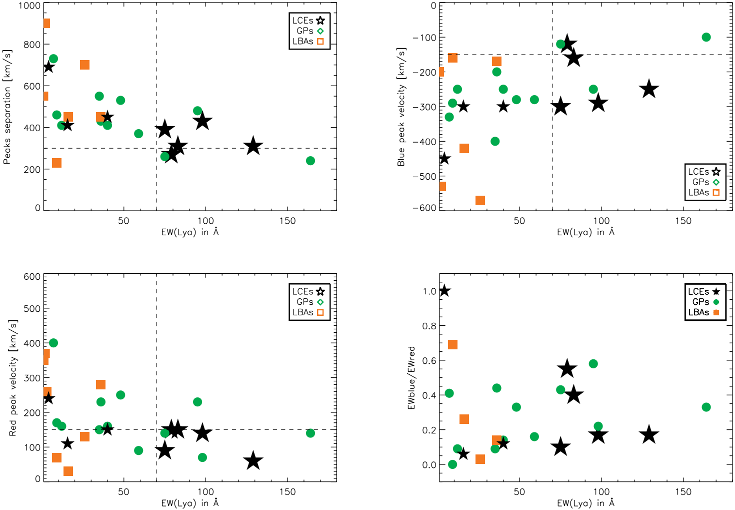


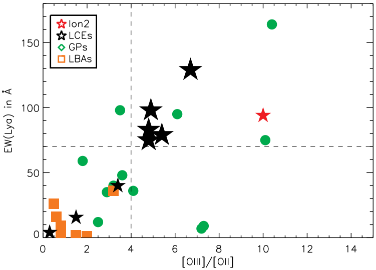
Their Lyα properties : narrow double-peaked profiles

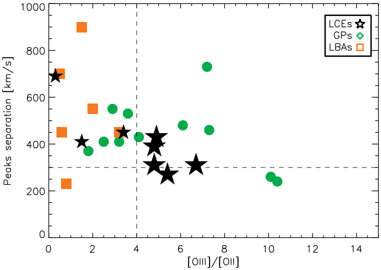


Their Lyα properties : comparison with LBAs and GPs

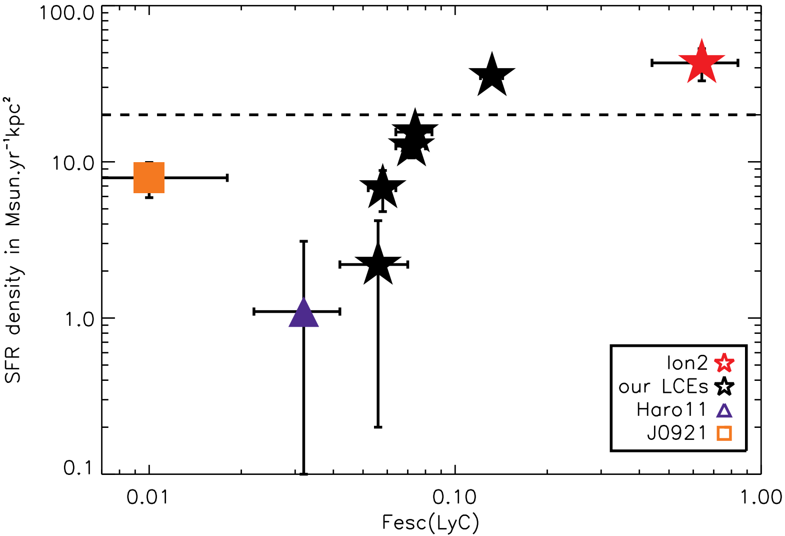


Connexion between indirect LyC leakage indicators

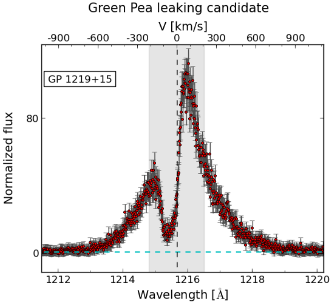




Insight on the physical reason for LyC escape



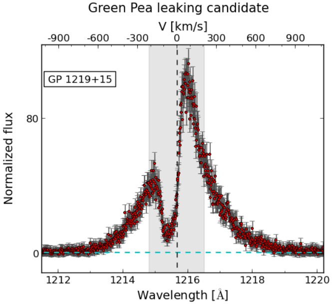
Using Lyα to detect LyC leakers



Verhamme et al. 2016, submitted

* a strong Lyα emission : EW(Lyα)$>$ 70Å,
* fesc(LyC)$>$ 10% $\rightarrow$fesc(Lya)$>$ 20%
* peaks separation $< 300 - 400$ km/s, driven by the blue peak shift
* no underlying Lyα absorption

Using Lyα to detect LyC leakers



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* no underlying Lyα absorption
* high OIII/OII ratio
* compact