Lyman α escape fraction in star forming galaxies at high redshift

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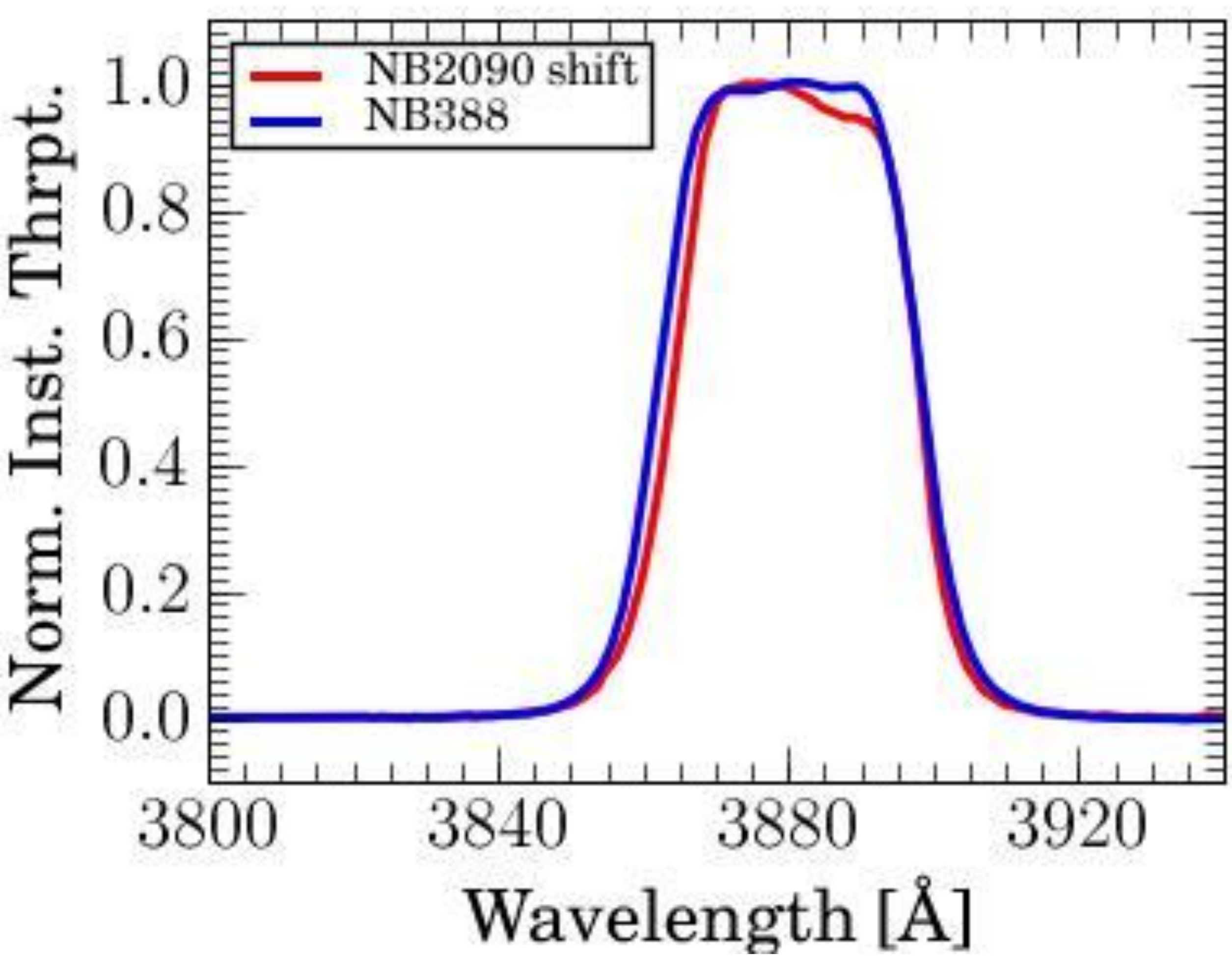
The Double-Blind Survey

- Objective: Simultaneous Lyman α and Hα surveys of the same cosmological volume at redshift *z~2.2*
- GOODS-S field (7.'5×7.'5):
  - HAWK-I: NB2090+K_s
  - FORS1: custom built NB388 + U+B
- Hα:
  - AB limit ~24.6 → 6.8×10^{-18} erg s^{-1} cm^{-2}, W_0(Hα) > 20Å
  - unobscured SFR ~1.9 $M_\odot$ yr^{-1}
- Lyα:
  - AB limit ~26.4, → 7.8×10^{-18} erg s^{-1} cm^{-2}, W_0(Lyα) > 20Å
  - unobscured SFR ~0.25 $M_\odot$ yr^{-1} (assuming case B Lyα=8.7×Hα)
  - absorbed (*fesc = 0.13*) $SFR_{Ly\alpha} = SFR_{H\alpha}$

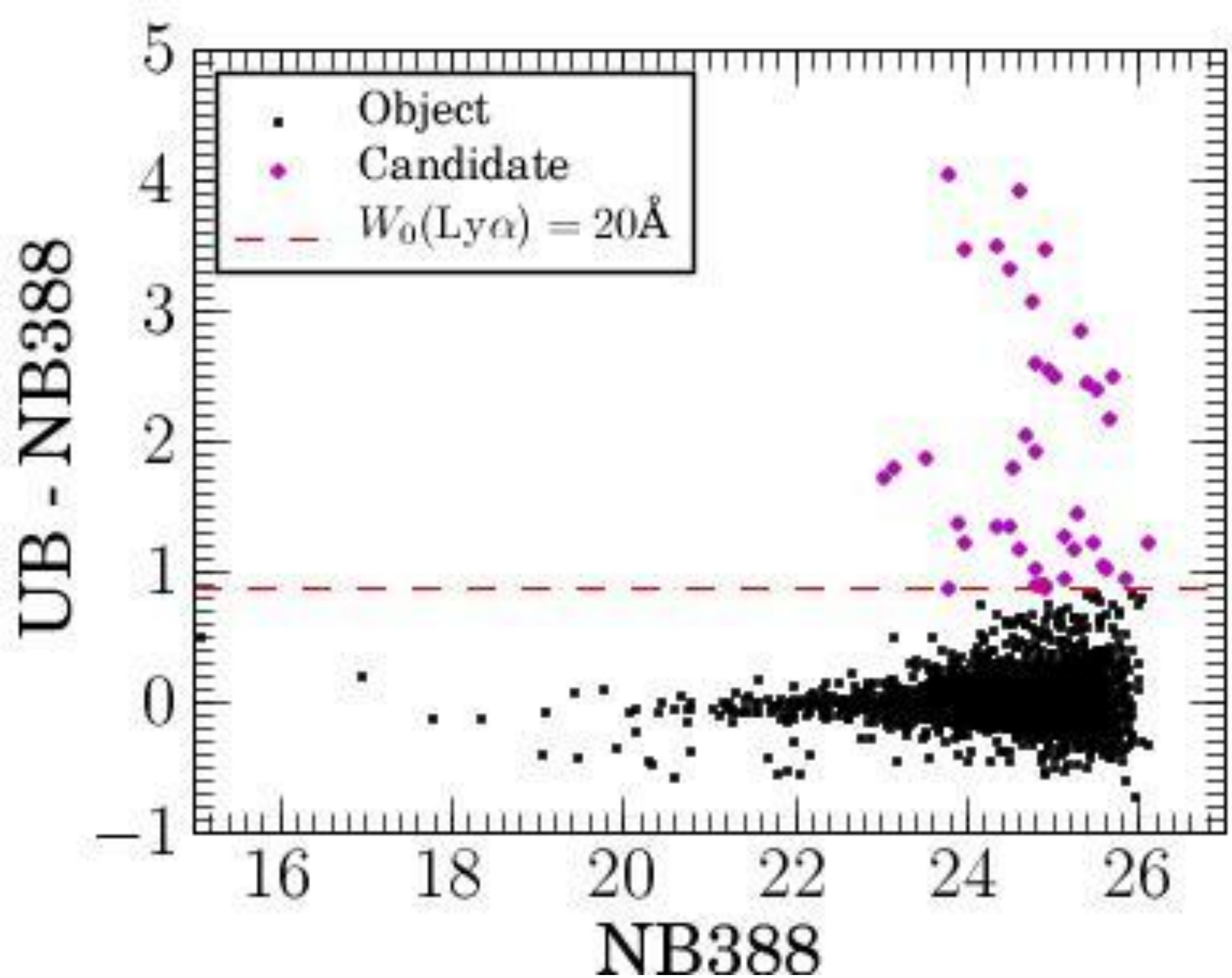
The Double-Blind Survey

- The NB388 filter was built to cover the same volume than the existing NB2090.



The Double-Blind Survey

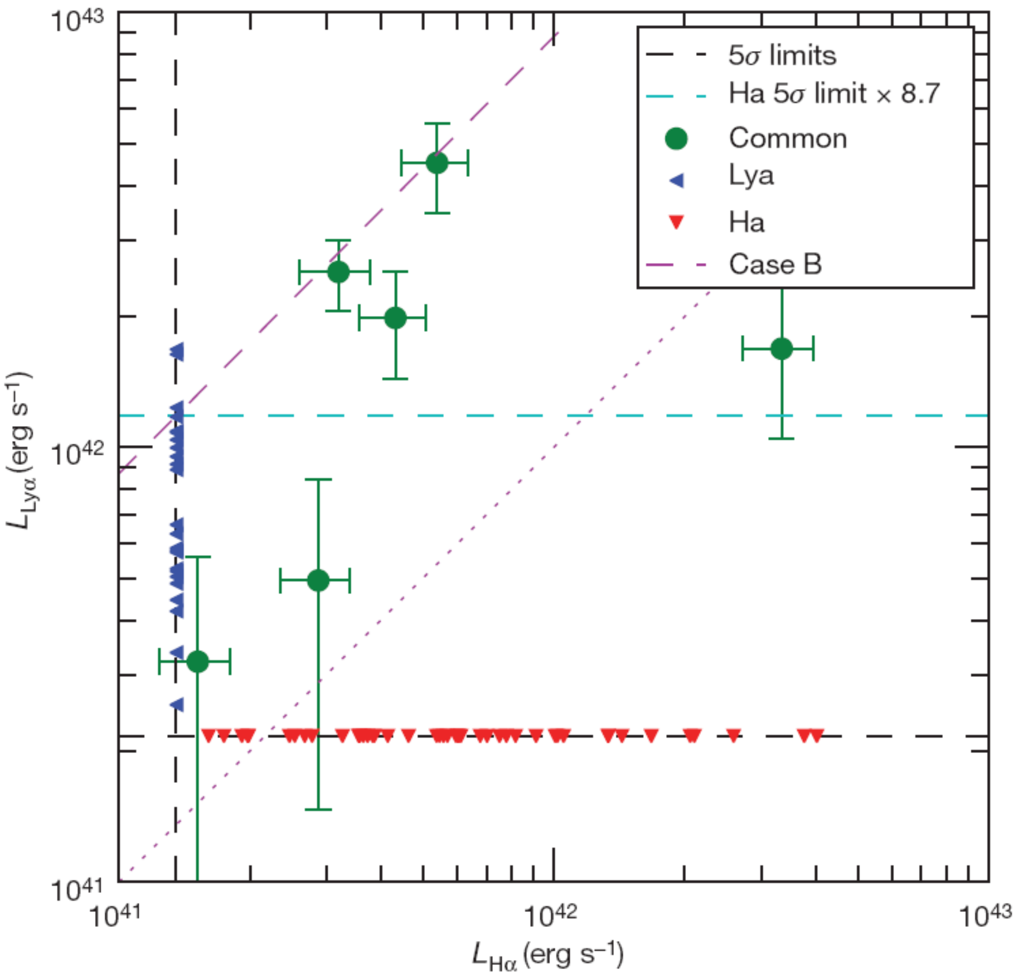
- Lyman α emitters are clearly detected at W(Lyα)>20 Å.



Results

- 55 Hα emitters
- 38 Lyα emitters

→ *Only 6 objects identified both in Hα and Lyα*



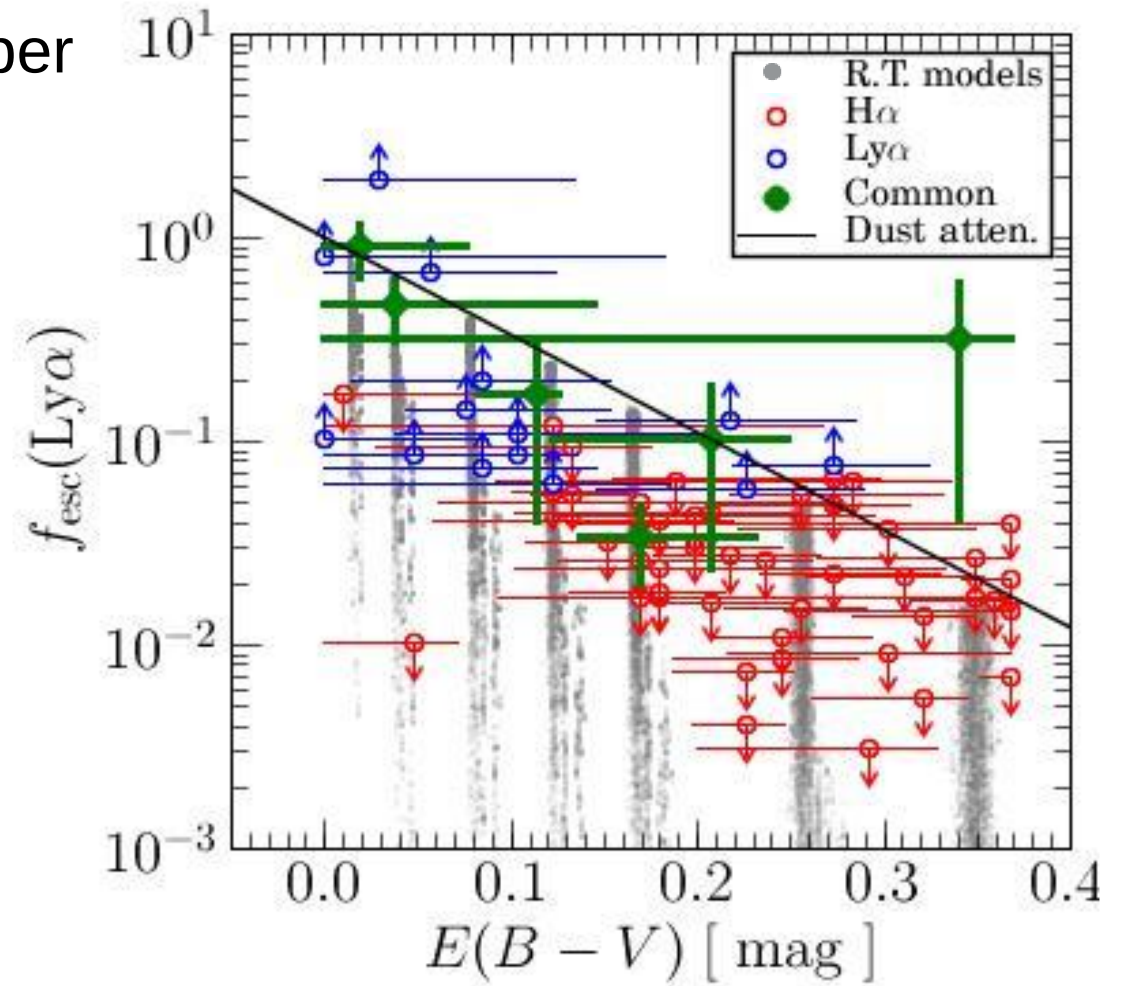
Results

- We compute the escape fraction (upper/lower limits) comparing Lyα(Hα) with the Hα(Lyα) flux upper limits, assuming case B recombination (Lyα = 8.7×Hα).

- E(B-V) is derived from multiwavelength SED fitting using the GOODS-MUSIC database (55 + 18 SED available).

Results

- The escape fraction upper envelope is clearly correlated with E(B-V).
- Lyman α emitters dominate at low E(B-V)
- Hα emitters predominantly at high E(B-V)



Results

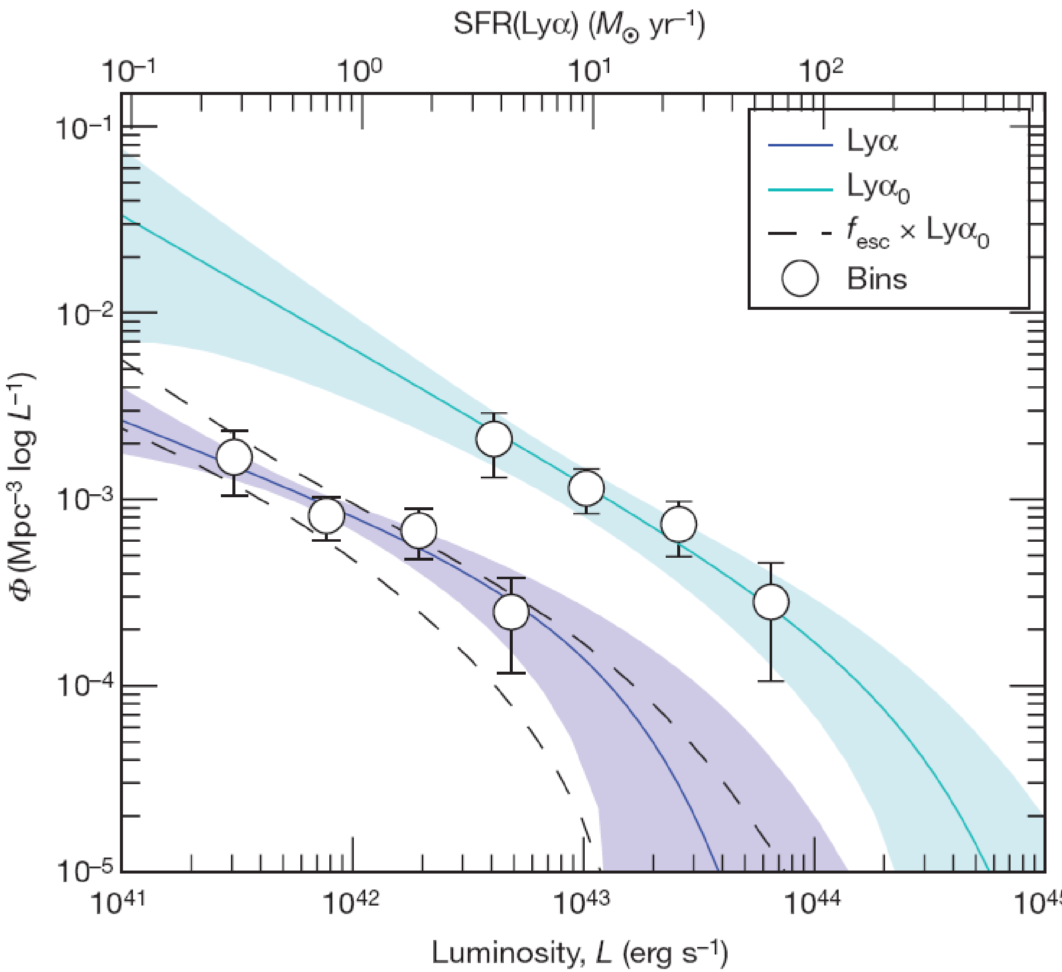
- Only 10% of Hα emitters are detected in Lyman α. Radiation transfer effects at z~2.2 (a combination of dust abundance and resonant scattering in static or outflowing neutral gas) lead to the destruction of the majority of Lyα photons, making the galaxies too weak in Lyman α to be detected.

- Only Lyman α emitters with *fesc > 0.1* are detected. Their Hα emission is too weak to be detected in our survey.

Results

- Comparing the luminosity function of both samples we derive *fesc ~0.05* (volumetric average)

→ *Only 1 in 20 Lyα photons escapes the star formation region and is potentially detected.*



Conclusions

- Lyman α emission is extremely sensitive to the properties of the surrounding medium.
- Hα or continuum surveys sample a very different population of star forming galaxies than Lyman α.
- Star formation rate volumetric densities derived from Lyα luminosities alone can be underestimated by 95% if these effects are not taken into account.
  - Lyman α surveys have to be treated with care.
- Even with small amounts of dust and neutral gas, the effects of radiation transfer lead to a large range of *fesc* values.
  - These effects are also expected at very high redshifts: $z>4$