Multiwavelength AGN Surveys and Studies
Proceedings IAU Symposium No. 304, 2013
A. M. Mickaelian & D. B. Sanders, eds.

doi:10.1017/S1743921314003214

A Deep Narrow Band Imaging Search for CIVλ1548Å and HeIIλ1640Å Emission from Lyman Alpha Blobs

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Abstract. To study the nature of Lyα blobs (*aka* LABs), we conduct a deep C IV and He II narrowband imaging survey of 13 Lyα blobs located in SSA22 proto-cluster at $z \sim 3.1$. We reach the unprecedented sensitivity, 5σ surface brightness limit of $2.1 - 3.4 \times 10^{-18}$ erg s^{-1} cm^{-2} arcsec^{-2} per 1 arcsec^2 aperture for two emission lines. We do not detect any extended C IV and He II emission, placing strong upper limits on the He II/Lyα and C IV/Lyα line ratios. We compare our limits with data in the literature related to the nebulae associated with high-redshift radio galaxies (HzRGs) and quasars, and we recover the data by modeling the LABs as nebulosities powered by a central QSO. For further information see Arrigoni Battaia *et al.* (2014).

Keywords. LAB, QSO, CGM, photoionization

1. Introduction

The recently discovered giant Lyα nebulae, the so-called Lyα blobs (LABs), are large (50–100 kpc) spatially extended regions emitting copious amounts of Lyα emission [$L(\mathrm{Ly}\alpha) \sim 10^{43-44}$ erg s^{-1}] (e.g., Yang *et al.* 2009). Despite the intense interest, what powers these gigantic gas halos are still not understood. The proposed scenarios include photoionization by AGNs, shock-heated gas by galactic superwinds, cooling radiation from cold-mode accretion, and resonant scattering of Lyα from star-forming galaxies.

The dominant mechanism powering these extreme objects remains unclear mainly because of the lack of other emission line diagnostics besides strong Lyα lines. In this work, to distinguish among various mechanisms for powering Lyα blobs, we present very deep narrowband imaging observations tuned to the C IV λ1549 and He II λ1640 emission lines of 13 Lyα blobs at $z \sim 3.1$. Our observations exploit the fortuitous match between two narrowband filters on VLT/FORS2 and these two emission lines from a large sample of Lyα blobs that were discovered in the SSA22 proto-cluster region at $z = 3.1$ (Steidel *et al.* 2000, Matsuda *et al.* 2004). Because this region shows a remarkable overdensity of Lyα emitters (LAEs) and LABs, we are able to carry out a statistical study of C IV/Lyα and He II/Lyα line ratios for a large sample of LABs.

2. Data

We obtain deep C IV and He II narrowband images of 13 LABs including the two largest LABs that were originally discovered by Steidel *et al.* (2000). Data were taken in service-mode using the FORS2 instrument on the VLT 8.2m. We use two narrowband filters, OI/2500+57 and SII+62, matching the redshifted C IV λ1549 and He II λ1640 at $z = 3.1$, respectively. The OI/2500+57 filter has a central wavelength of $\lambda_c \approx 6354$ Å

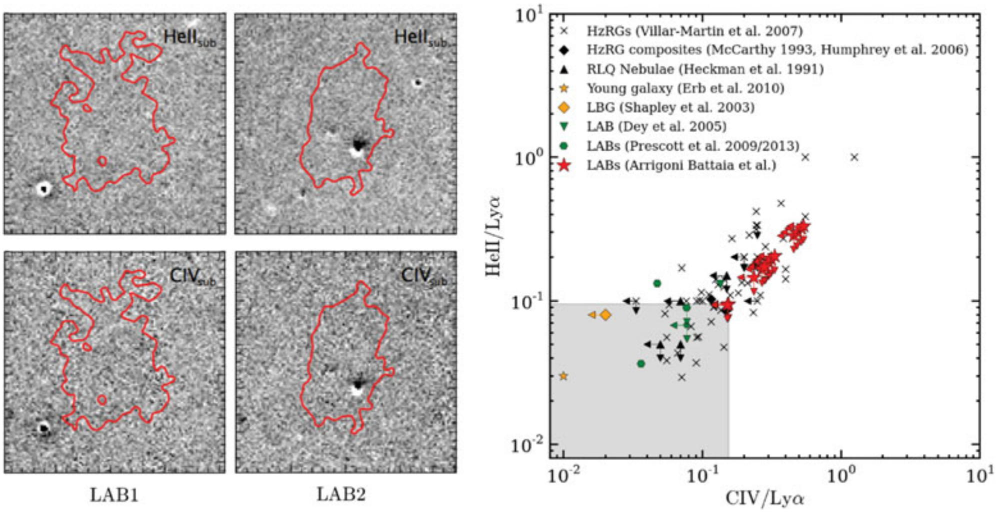

Figure 1. Left: Continuum-subtracted images of LAB1 and LAB2 in the He II line (top panels) and C IV line (bottom panels). The 2σ Lyα isophotes are shown in red (Matsuda *et al.* 2004). Note the lack of extended emission. **Right**: HeII/Lyα versus CIV/Lyα log-log plot. Our upper limits on the HeII/Lyα and CIV/Lyα ratios are compared with the values quoted in the literature for HzRG, QSOs, and LABs. Due to their larger size, LAB1 and LAB2 define the strongest limits on these ratios: the gray shaded area highlights the regime constrained by these limits. Note however that these data are quite difficult to compare because of their heterogeneity.

and has a bandwidth of $\Delta\lambda_{\rm FWHM} \approx 59$ Å, while the SII+62 filter has $\lambda_c \approx 6714$ Å and $\Delta\lambda_{\rm FWHM} \approx 69$ Å. To subtract continuum from our narrowband images and compare the C IV and He II line fluxes with those of Lyα, we rely on previous Subaru observations by Hayashino *et al.* (2004), who observed the SSA22 field in B, V, R, i', and NB497 bands.

3. Overview of the Results

For all LABs in our sample, we do not detect any extended C IV and He II emission comparable to the Lyα line down to ours sensitivity limits (see above). Figure 1 is a He II/Lyα versus C IV/Lyα log-log plot where we highlights with red stars the 5 sigma upper limits for LABs in our sample, in comparison with all previous measurements for LABs (Prescott *et al.* 2013), and with all the Lyα nebulosities in the literature associated with HzRGs and quasars which have C IV and He II measurements. As there are points below our tighter limits, this Figure clearly state that other data are needed in order to really constrain the He II and C IV emission from the LABs in the SSA22 field. In order to understand how much deeper we need to go, we model LABs as nebulae powered by a central hard ionizing source (i.e. QSO), following the prescription in Hennawi & Prochaska (2013). See Arrigoni Battaia *et al.* (2014) for the complete analysis and results.

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https://doi.org/10.1017/S1743921314003214 Published online by Cambridge University Press