EXPLORING THE SPECTRAL PROPERTIES OF HIGHLY ACCRETING QUASARS AT HIGH REDSHIFT

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4D Eigenvector 1: an evolution diagram for type 1 AGN

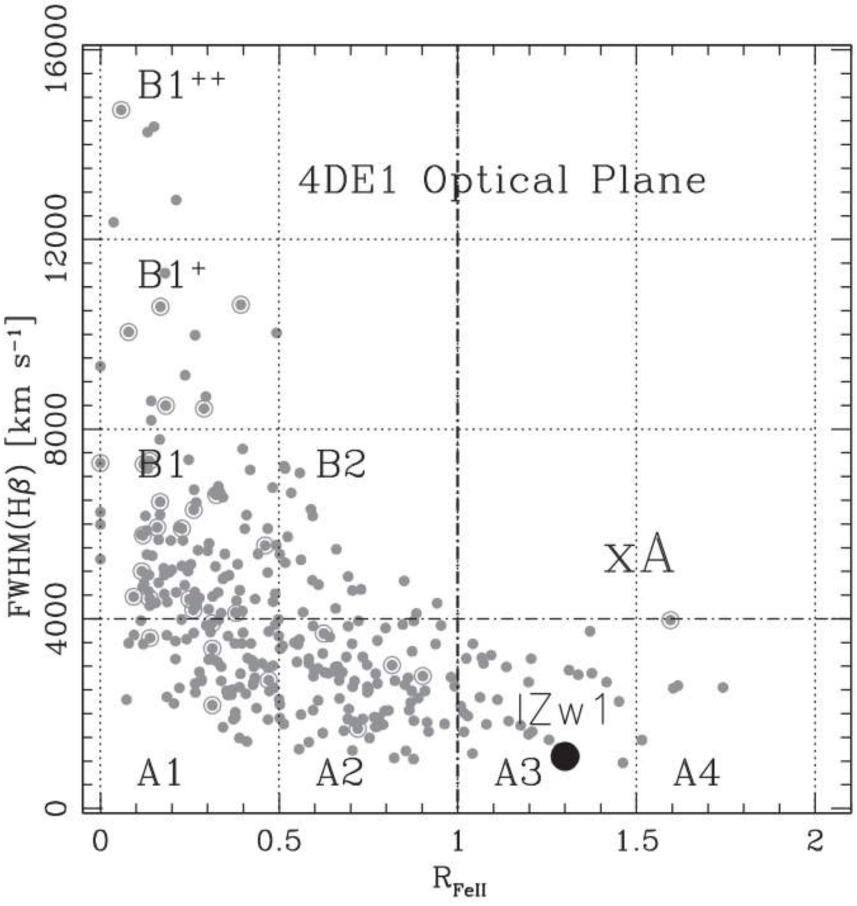
The **4D Eigenvector 1** (**4DE1**:Boroson & Green 1992; Sulentic+ 2000; Marziani+ 2001, 2003; Sulentic+ 2007, 2010, 2014) is a spectroscopic unifier/discriminator of the emission lines properties for type 1 AGN. It is based on four parameters:

1) FWHM($H\beta_{BC}$): prototype of LILs

2) $R_{Fe\,II}$=W(Fe II λ4570)/W($H\beta_{BC}$)

3) Γ_{soft}: spectral index of soft X-ray

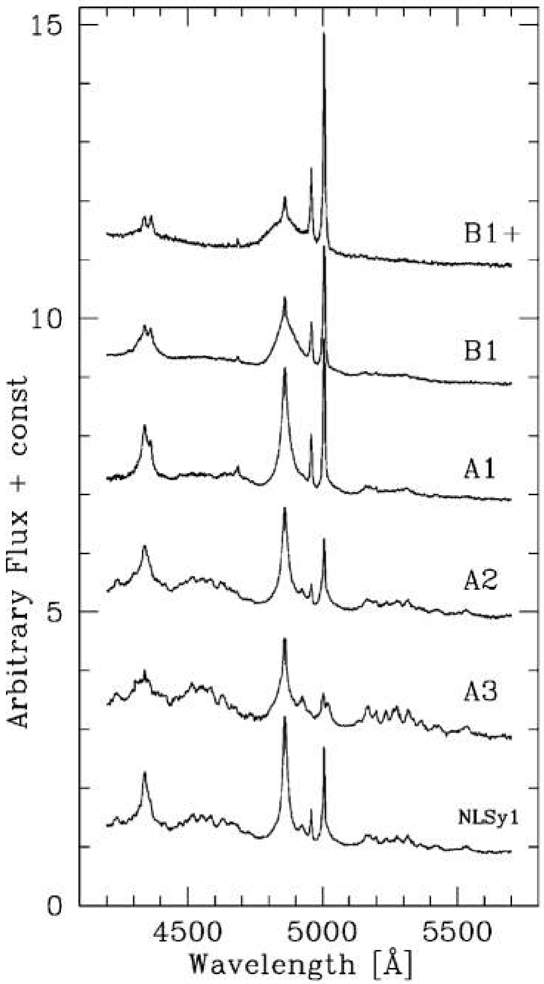
4) CIV λ1549 blueshift: prototype of HILs



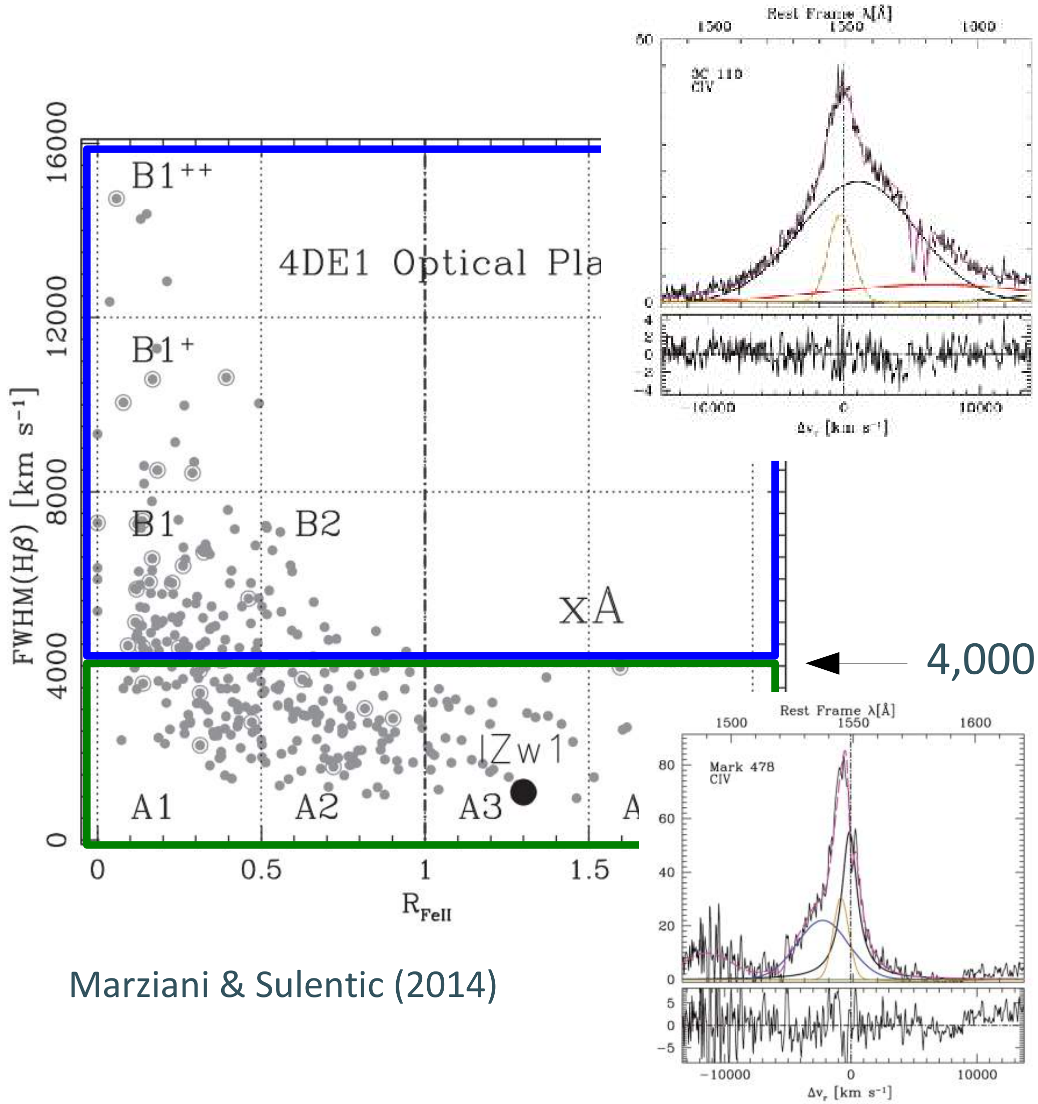
Marziani & Sulentic (2014)

4D Eigenvector 1: an evolution diagram for type 1 AGN

Along the 4DE1, we can find a change in the spectral properties of the AGN, suggesting the existence of two kind of populations: **A** and **B**



Sulentic+ (2002)

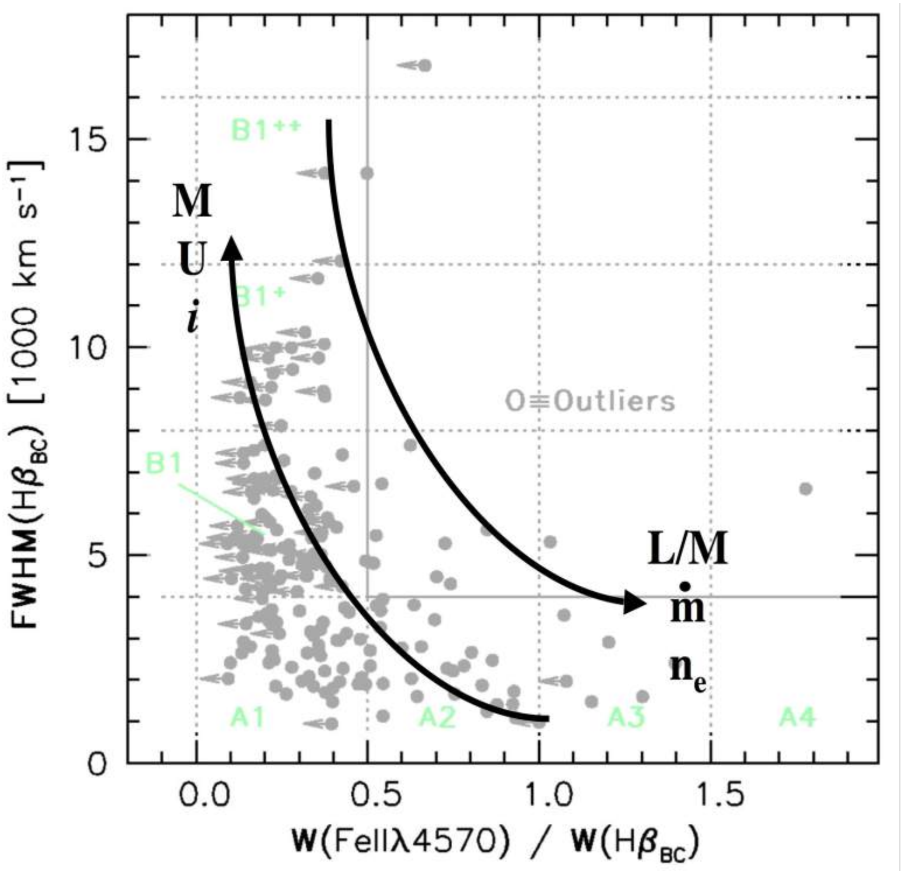


4,000 km s^{-1}

Marziani & Sulentic (2014)

4D Eigenvector 1: an evolution diagram for type 1 AGN

Furthermore, the 4DE1 sequence we can find a variation of the physical parameters and in the orientation. Then, the 4D Eigenvector 1 could be considered as a **"HR diagram"** for type 1 quasars (Sulentic, Marziani & Dultzin 2000, Zamfir+ 2010).



Zamfir+ (2010)

These results were confirmed by Shen & Ho (2013) using the SDSS data.

Highly accretors AGNs along the 4DE1

Considering several UV and optical samples (Bachev+ 2004; Marziani+ 2003, 2009; Negrete+ 2012, 2013; Sulentic+ 2004, 2007, 2014), we have identified the properties for the highly accretors AGNs. They are located in the **extreme population A region**.

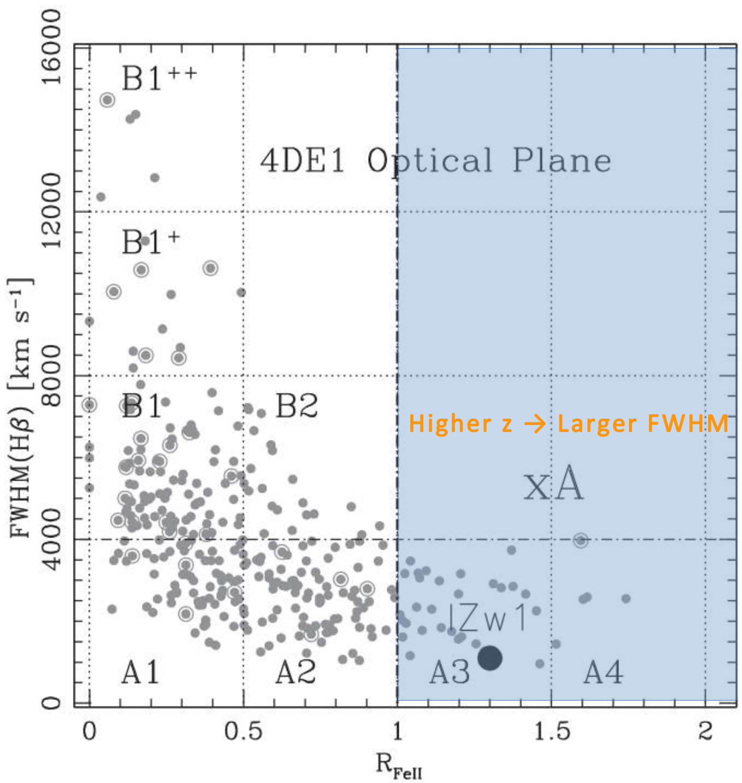
Optical criterion

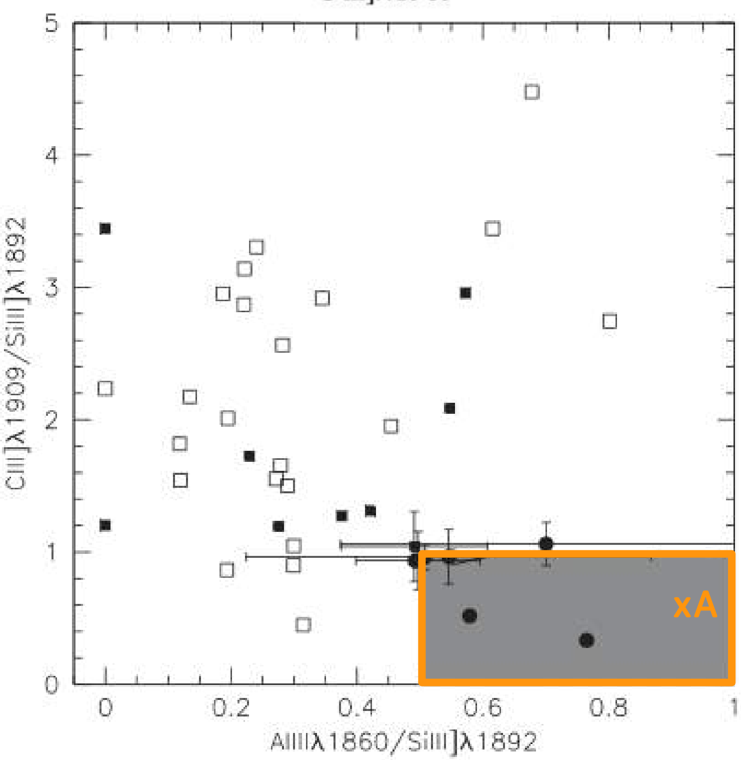
$R_{\mathrm{Fe\,II}} \geq 1.0$ → {A3, A4, xA}

UV criteria

$$\frac{\mathrm{Al\,III}\ \lambda 1860}{\mathrm{Si\,III]}\ \lambda 1892} \geq 0.5$$

$$\frac{\mathrm{Si\,III]}\ \lambda 1892}{\mathrm{C\,III]}\lambda 1909} \geq 1.0$$





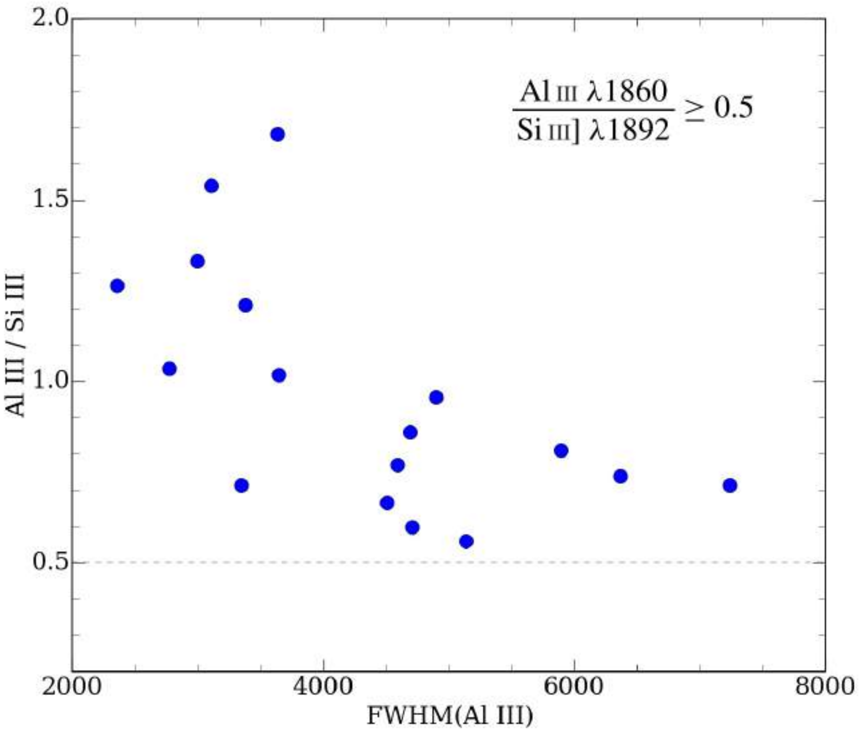
Marziani & Sulentic (2014)

GTC highly accretors sample

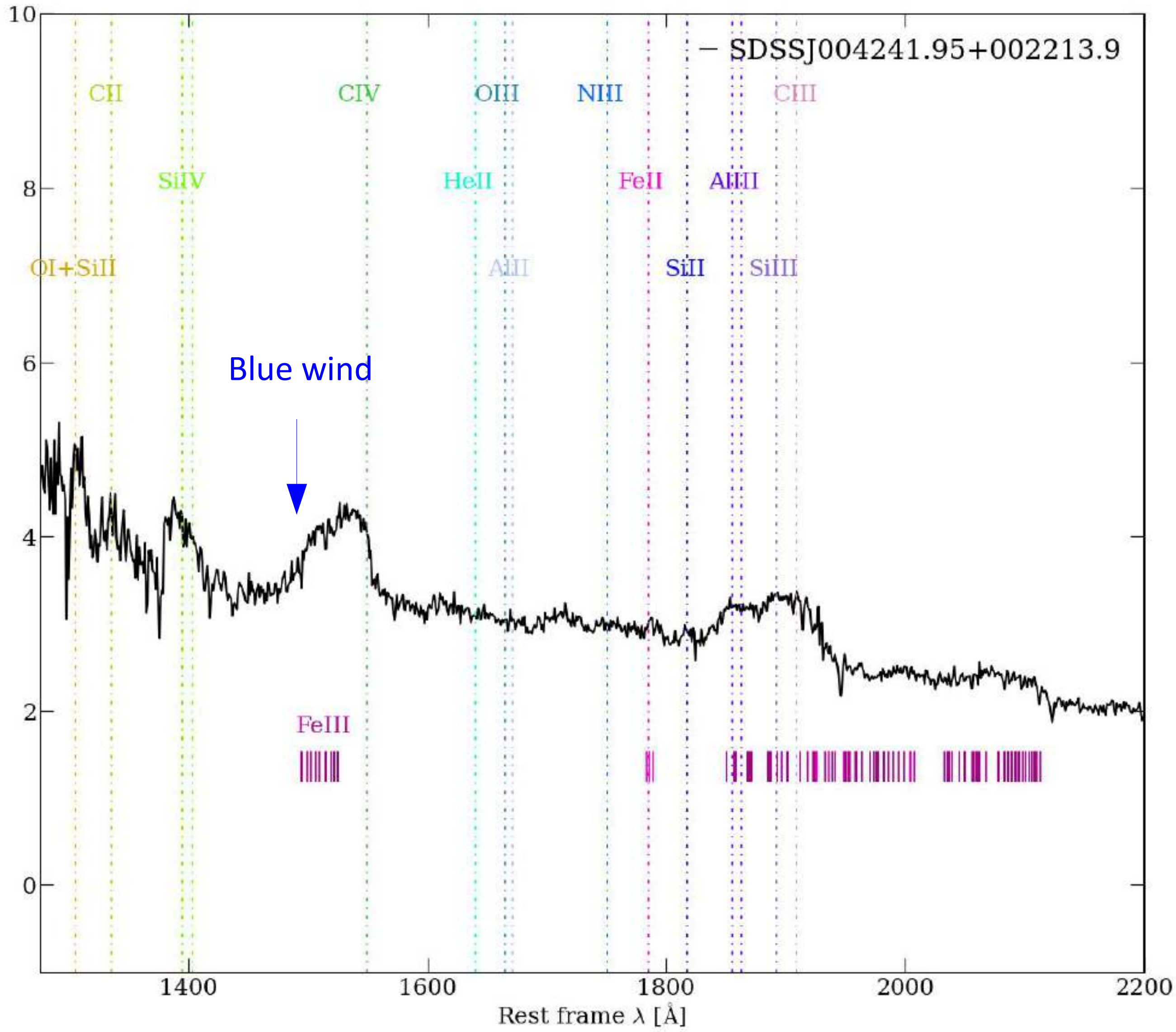
Using the **OSIRIS** spectrograph mounted in the **Gran Telescopio Canarias (GTC)**, we observed a sample of highly accretor quasars (~50 sources), which were selected with the **UV** criteria proposed by 4DE1.

QSO	z	Lines used
SDSSJ021606.41+011509.5	2.223585	OI+SiII,CII
SDSSJ222753.07-092951.7	2.163938	CII, Lya
SDSSJ000807.27-103942.7	2.466034	OI+SiII,CII, Lya
SDSSJ143525.31+400112.2	2.261532	OI+SiII,CII
SDSSJ110022.53+484012.6	2.079899	Si II1264, OI+SiII
SDSSJ024154.42-004757.5	2.391897	Si II1264, OI+SiII, CII
SDSSJ101822.96+203558.6	2.250155	Si II1264, OI+SiII
SDSSJ151258.36+352533.2	2.238270	OI+SiII, CII
SDSSJ214009.01-064403.9	2.080758	Si II1264, OI+SiII, CII
SDSSJ125659.79-033813.8	2.980083	OI+SiII
SDSSJ105806.16+600826.9	2.940572	OI+SiII,CII
SDSSJ103527.40+445435.6	2.263917	OI+SiII
SDSSJ084036.16+235524.7	2.184233	OI+SiII,CII
SDSSJ004241.95+002213.9	2.056166	OI+SiII,CII
SDSSJ131132.92+052751.2	2.123420	OI+SiII, CII
SDSSJ144412.37+582636.9	2.345544	Si II1264, OI+SiII
SDSSJ234657.25+145736.0	2.170262	Si II1264, CII
SDSSJ220119.62-083911.6	2.183952	AlIII, CIII, SiIII
SDSSJ233132.83+010620.9	2.627299	AlIII, CIII, SiIII

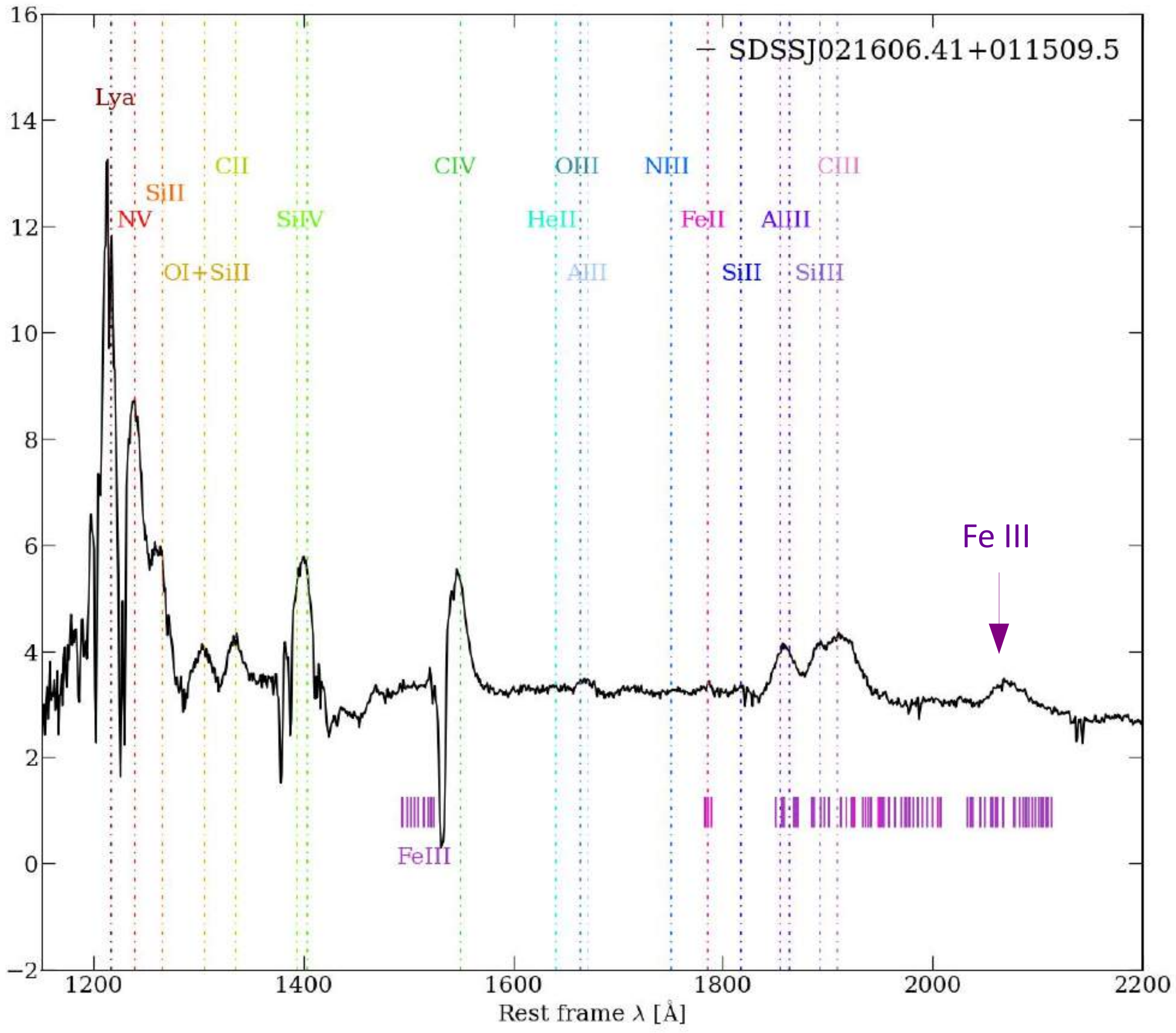
Extreme population A sources



Some examples: strong blueshifted CIV component



Some examples: Broad Absorption Line QSO

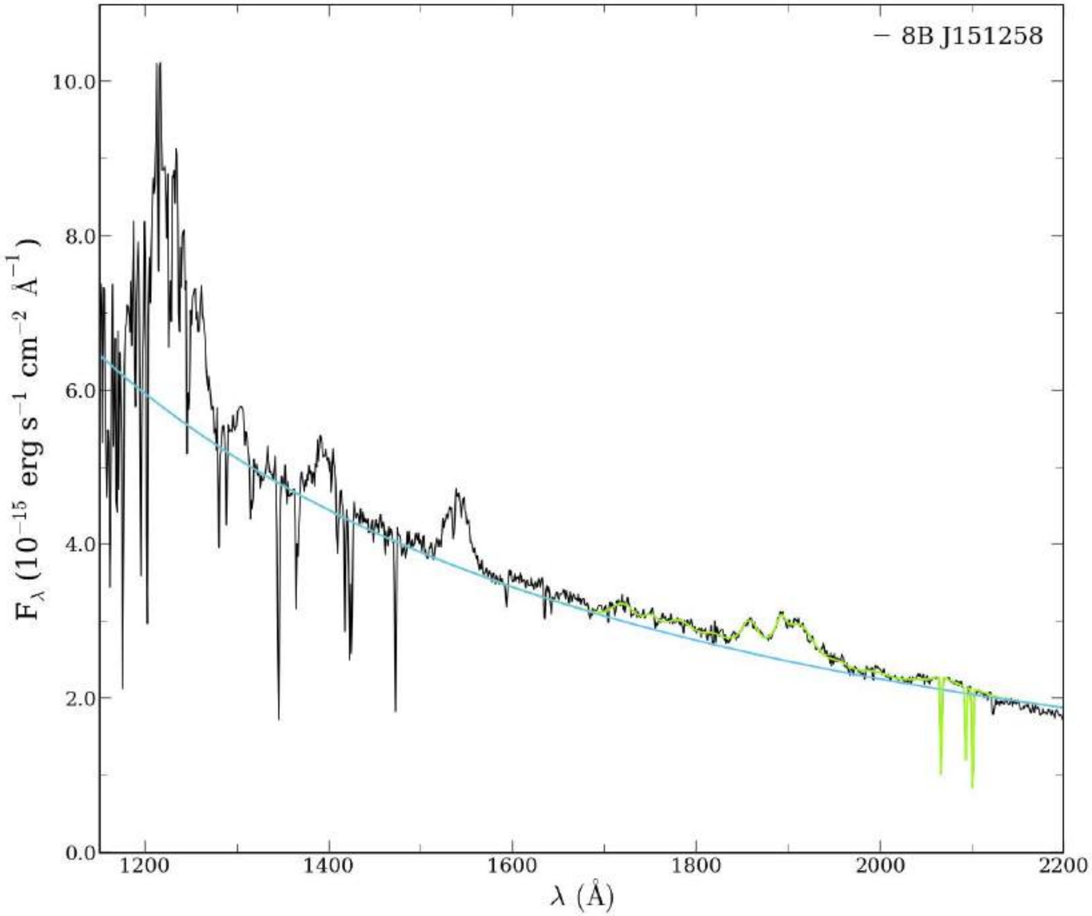


Multicomponents fits

Following the 4DE1 context we performed multicomponents fit to separate the different contributions.

Fitting criteria

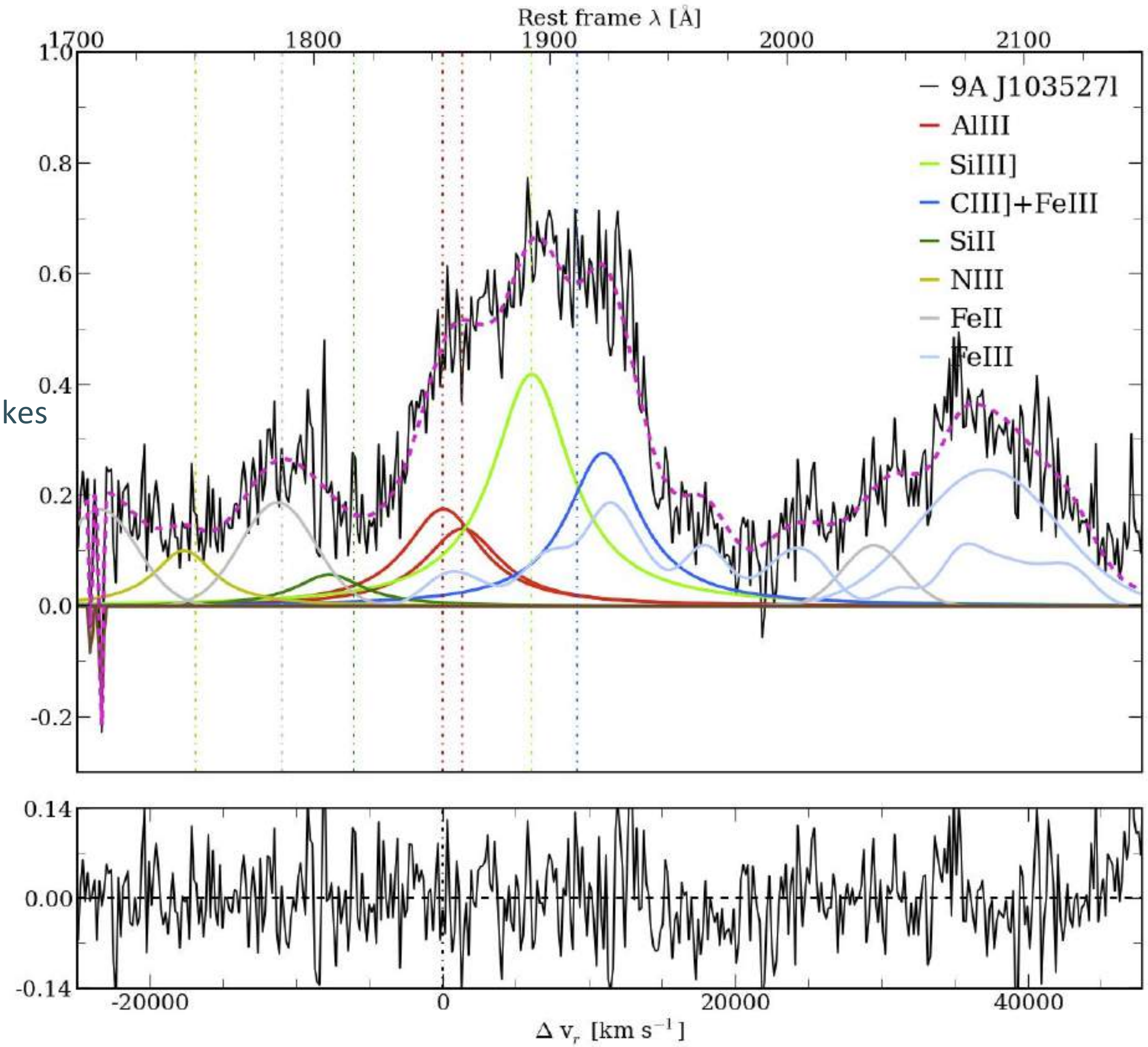
- Continuum: local or global
- Pop. A: lorentzian profiles
- Low Ionization Lines: BC
- High Ionization Lines: BC+Blueshift



Multicomponents fits: Blend 1900 Å

Blend 1900: 1700-2150 Å

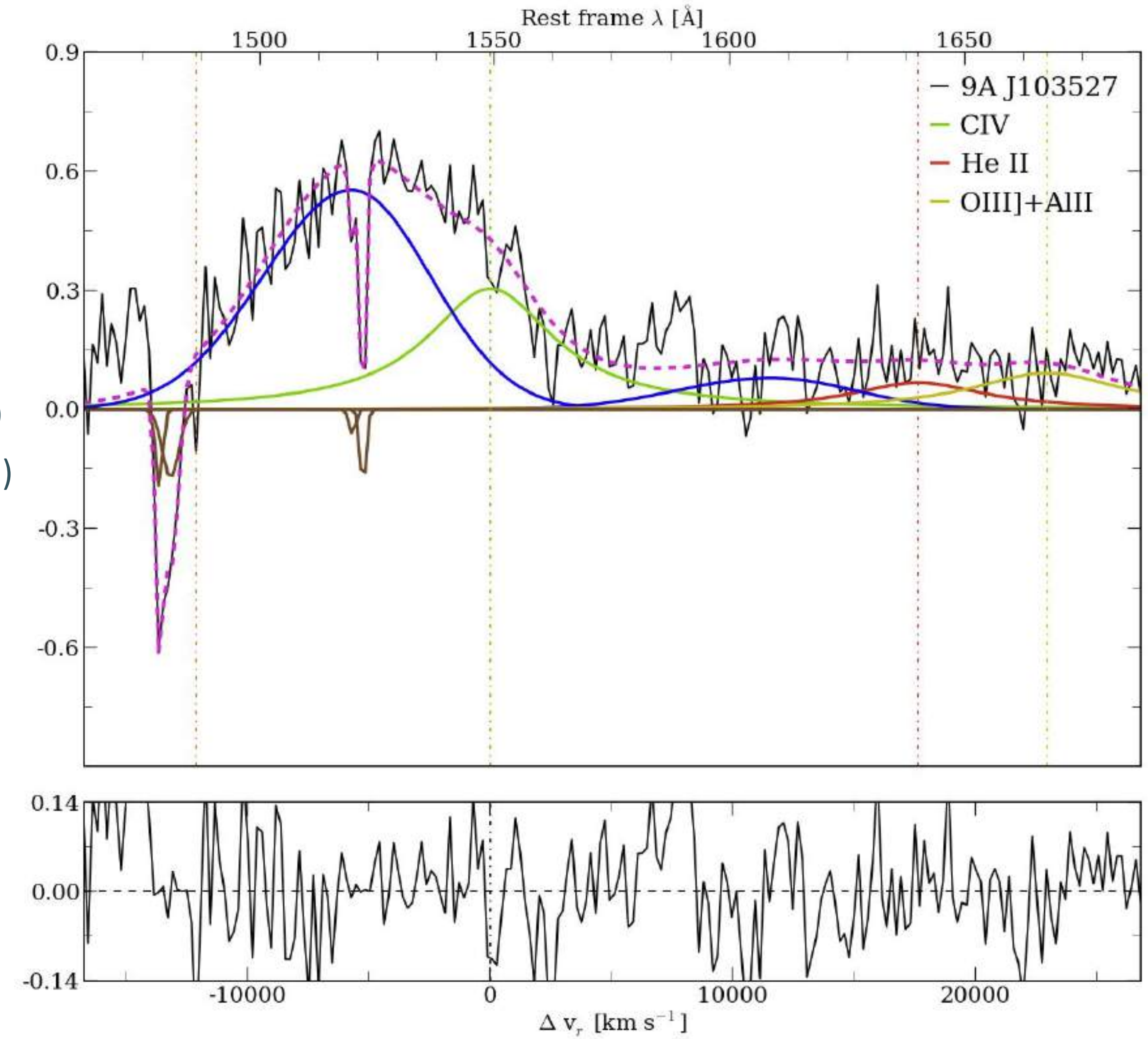
- Al III] λ1860
- Si III] λ1892
- C III] λ9009
- Si II λ1816
- N III λ1750
- Fe II: isolated gaussians at 1715, 1785, 2020 Å
- Fe III: Vestergaard & Wilkes (2001) + 2080 Å



Multicomponents fits: CIV λ1549

CIV region: 1500-1700 Å

- C IV λ1549: BC+Blueshift (2)
- He II λ1640: BC+Blueshift (2)
- OIII] λ1664 + Al II λ1670
- N IV λ1486



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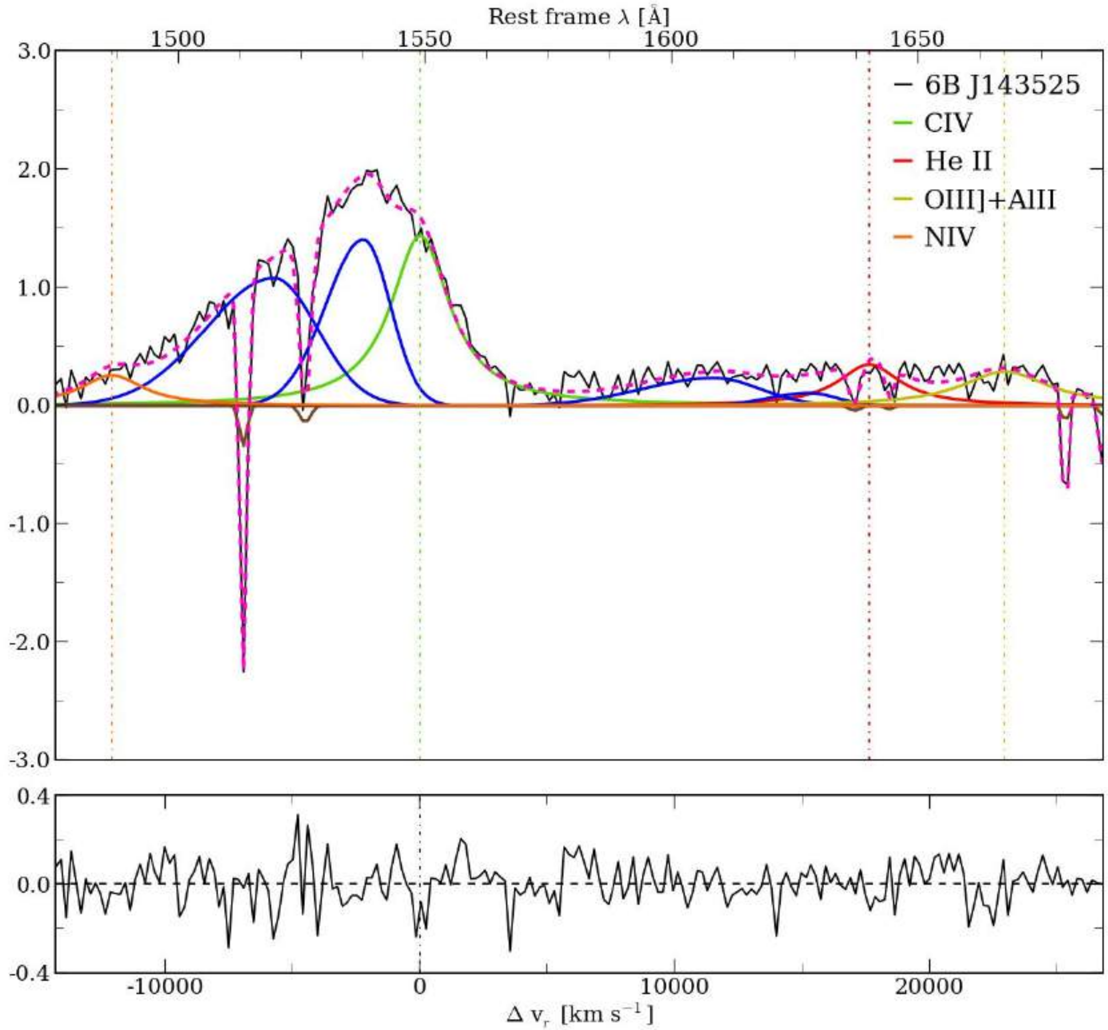
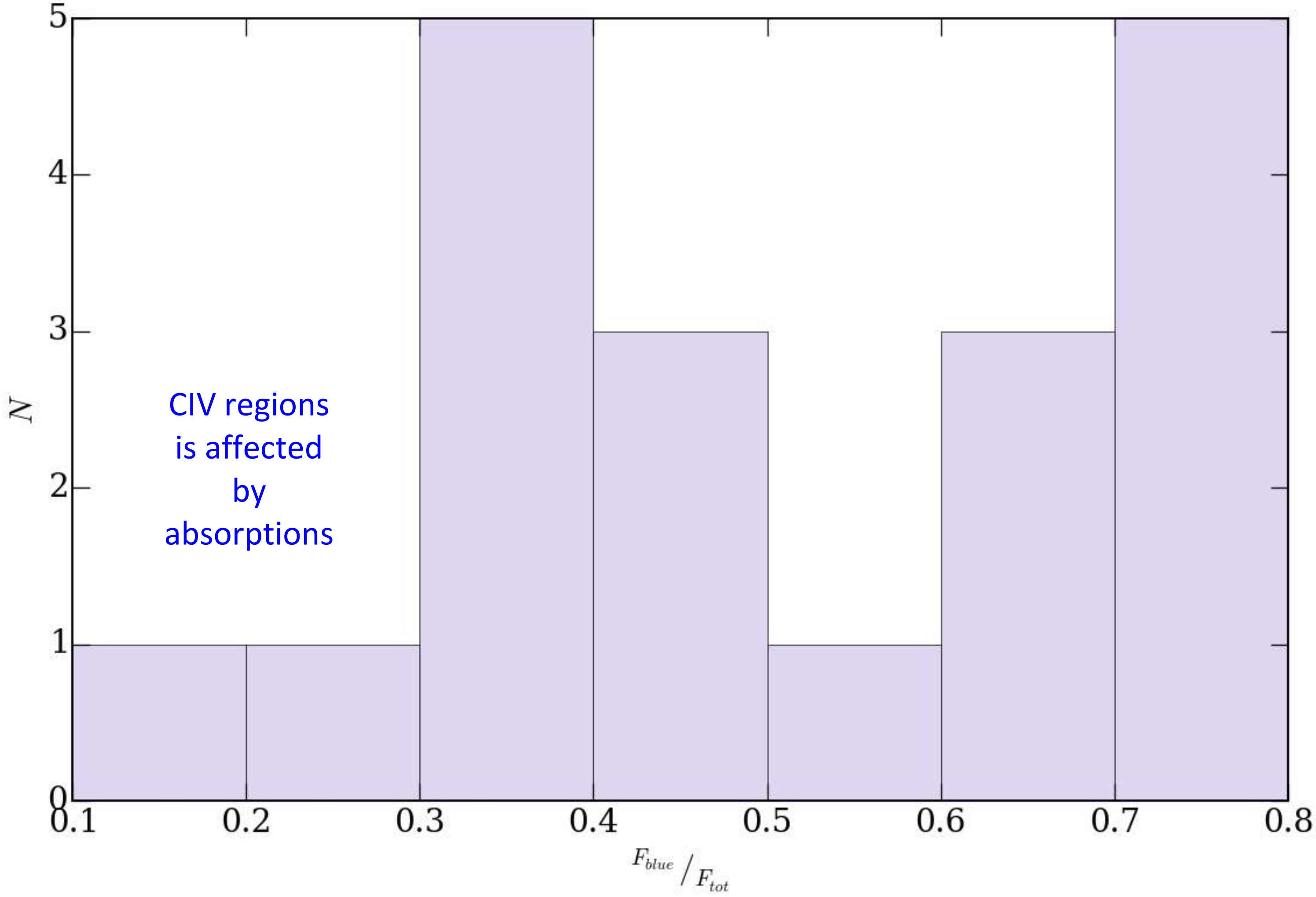


CIV λ1549 outflows

If we compare the contribution of the CIV λ1549 blue component respect to the total contribution, we find a contribution of more than 40% for the 65% of the sources.



Photoionization method

Considering the flux ratios of the UV lines, we can determined U and n_H using a photoionization models. And then, getting the size of the Broad Line Region, r_{BLR} (Negrete+ 12,13,14).

Ionization parameter

$$U = \frac{\int_{\nu_0}^{+\infty} \frac{L_\nu}{h\nu} d\nu}{4\pi n_{\rm H} c r^2}$$

→

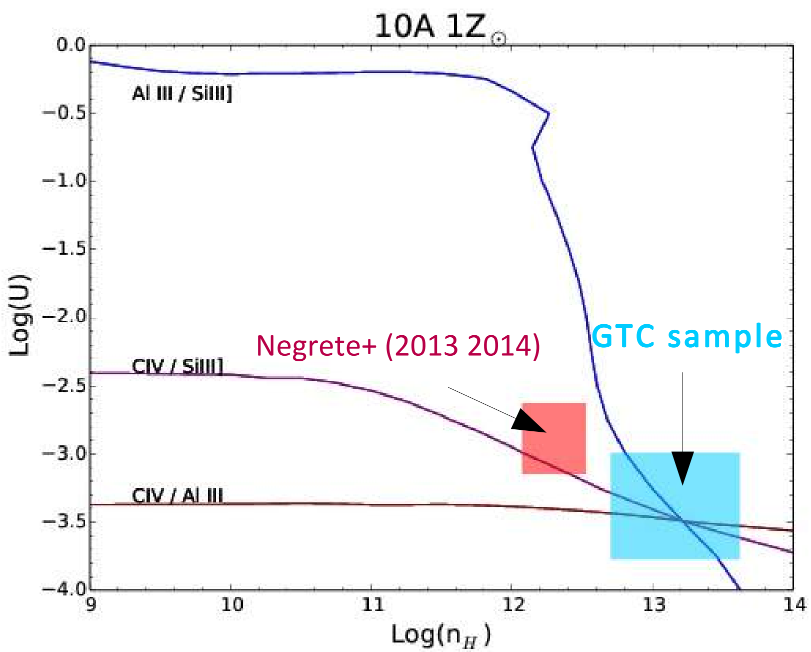
Broad Line Region size

$$r_{BLR} = \left[\frac{\int_{\nu_0}^{+\infty} \frac{L_\nu}{h\nu} d\nu}{4\pi U n_{\rm H} c} \right]^{1/2}$$

CLOUDY (Ferland+ 2013) input conditions:

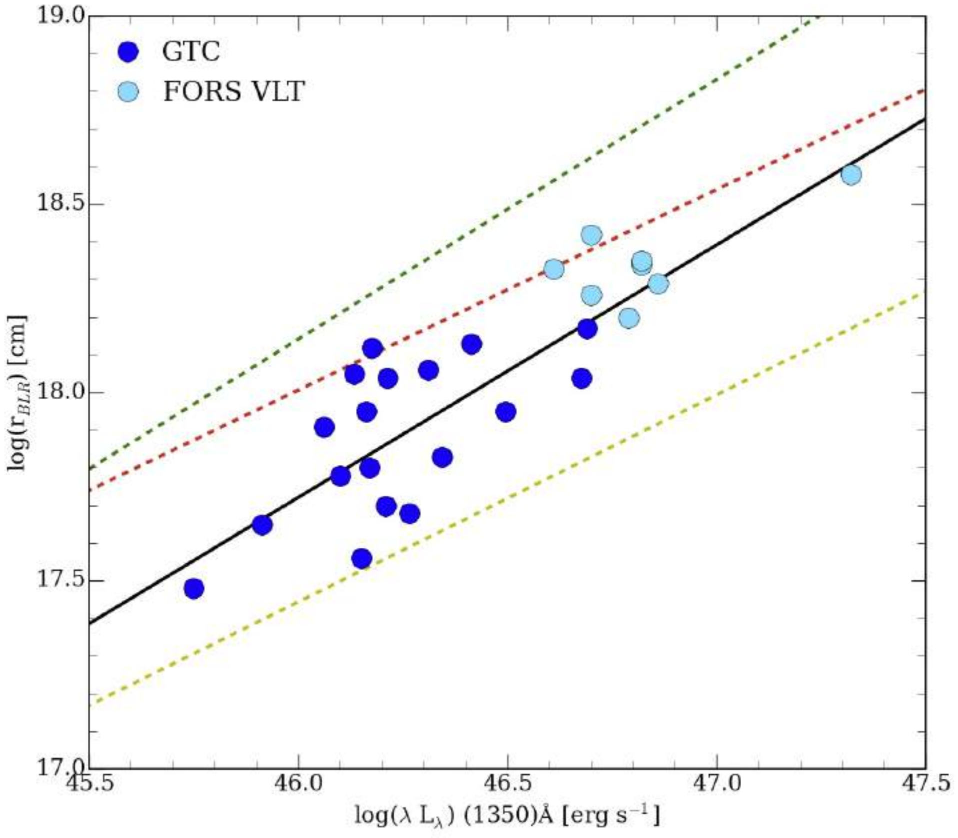
- Mathews & Ferland continuum (1987)
- $Nc=10^{23-25}$ cm^{-2}
- $1Z_o$, $5Z_o$
- $4 \leq \log(U) \leq 0$
- $9 \leq \log(n_H) \leq 14$

SDSSJ084036.16+235524.7, $1Z_o$



Broad Line Region size

Considering a small high-z sample but not highly accretor (Negrete+ 2012, 2013), we find that the tendence previously found for the r_{BLR} size is in agreement with our results adn the BLR radii is smaller than the computing wih the RM methods.



Photionization model

Negrete+ (2012)

$$r_{BLR} = \frac{1}{h^{(1/2)}c}(UN_e)^{(1/2)}\left(\int_0^{\lambda_{Ly}} f_\lambda \lambda d\lambda\right)^{(1/2)} d_p$$

Reverberation mapping *5100·L*$_{5100}$

Vestergaard+ (2005): Hβ

$$\frac{R_{\mathrm{BLR}}}{10\ \mathrm{lt\text{-}days}} = (2.23 \pm 0.21)\left[\frac{\lambda L_\lambda(5100\ \text{Å})}{10^{44}\ \mathrm{ergs\ s^{-1}}}\right]^{0.69\pm0.05}$$

Kaspi+ (2007): CIV λ1549

$$\log(R_{\mathrm{BLR}}/1\ \mathrm{lt\text{-}day}) = 1.527^{+0.031}_{-0.031} + 0.533^{+0.035}_{-0.033}\log(\lambda L_\lambda/10^{44}\ L_\odot)$$

Bentz+ (2013): Hβ

$$\frac{R_{\mathrm{BLR}}}{10\ \mathrm{lt\text{-}days}} = (0.24 \pm 0.06)\left[\frac{\lambda L_\lambda(1350\ \text{Å})}{10^{43}\ \mathrm{ergs\ s^{-1}}}\right]^{0.55\pm0.04}$$

Black hole mass determination

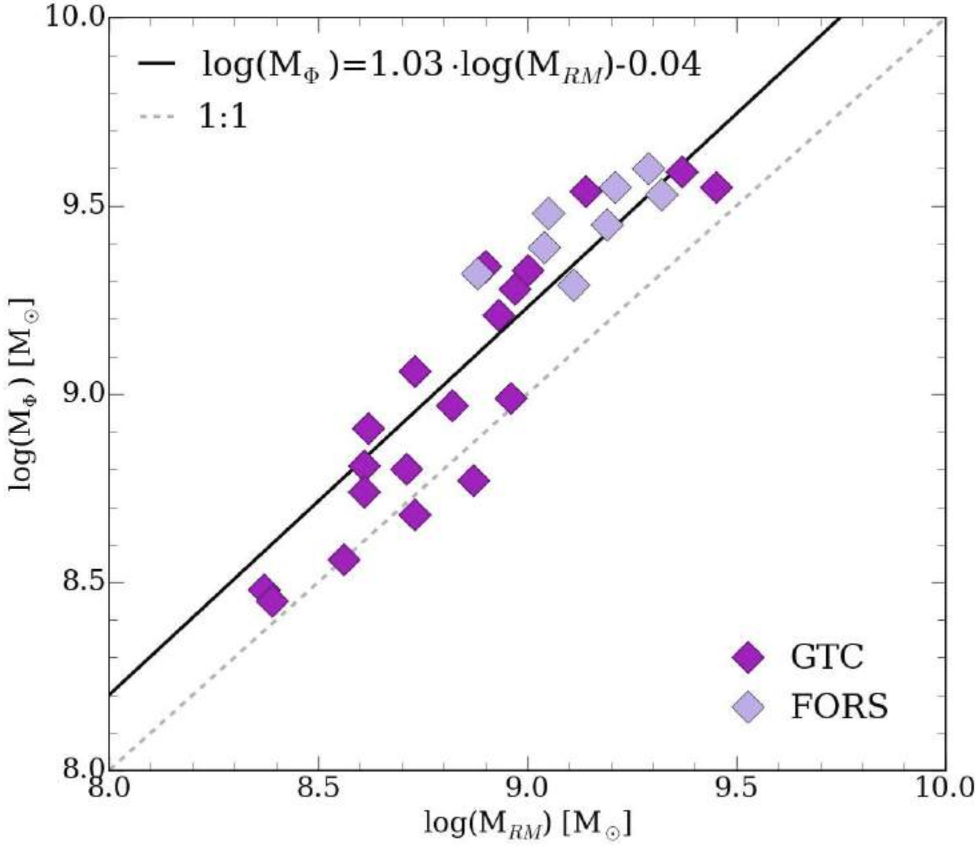
Computing the black hole mass using r_{BLR} the found, we get that the mass obtained from the photoionization models (GTC+FORS) is slighly higher than the obtained from reverberation mapping.

$M_{BH,\Phi}$ — Negrete (2012)

$$M = \frac{3}{4G} f_{0.75} r_{BLR} (FWHM)^2$$

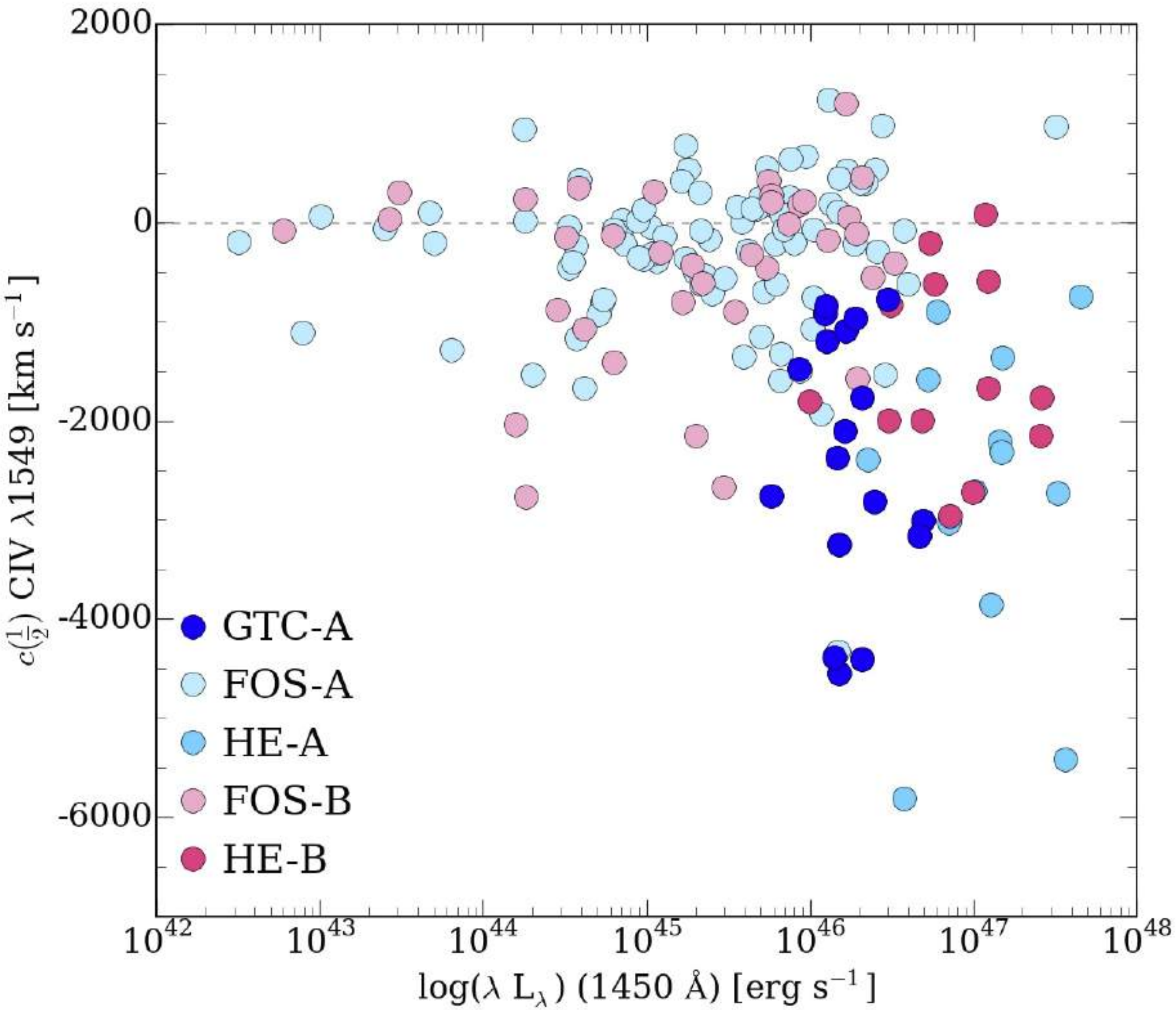
$M_{BH,RM}$ — Vestergaard & Peterson (2006)

$$\log M_{BH}(\mathrm{C\ IV}) = \log\left\{\left[\frac{\mathrm{FWHM(C\ IV)}}{1000\ \mathrm{km\ s^{-1}}}\right]^2 \left[\frac{\lambda L_\lambda(1350\ \text{Å}}{10^{44}\ \mathrm{ergs\ s^{-}}}\right.\right.$$
$$+ (6.66 \pm 0.01)$$



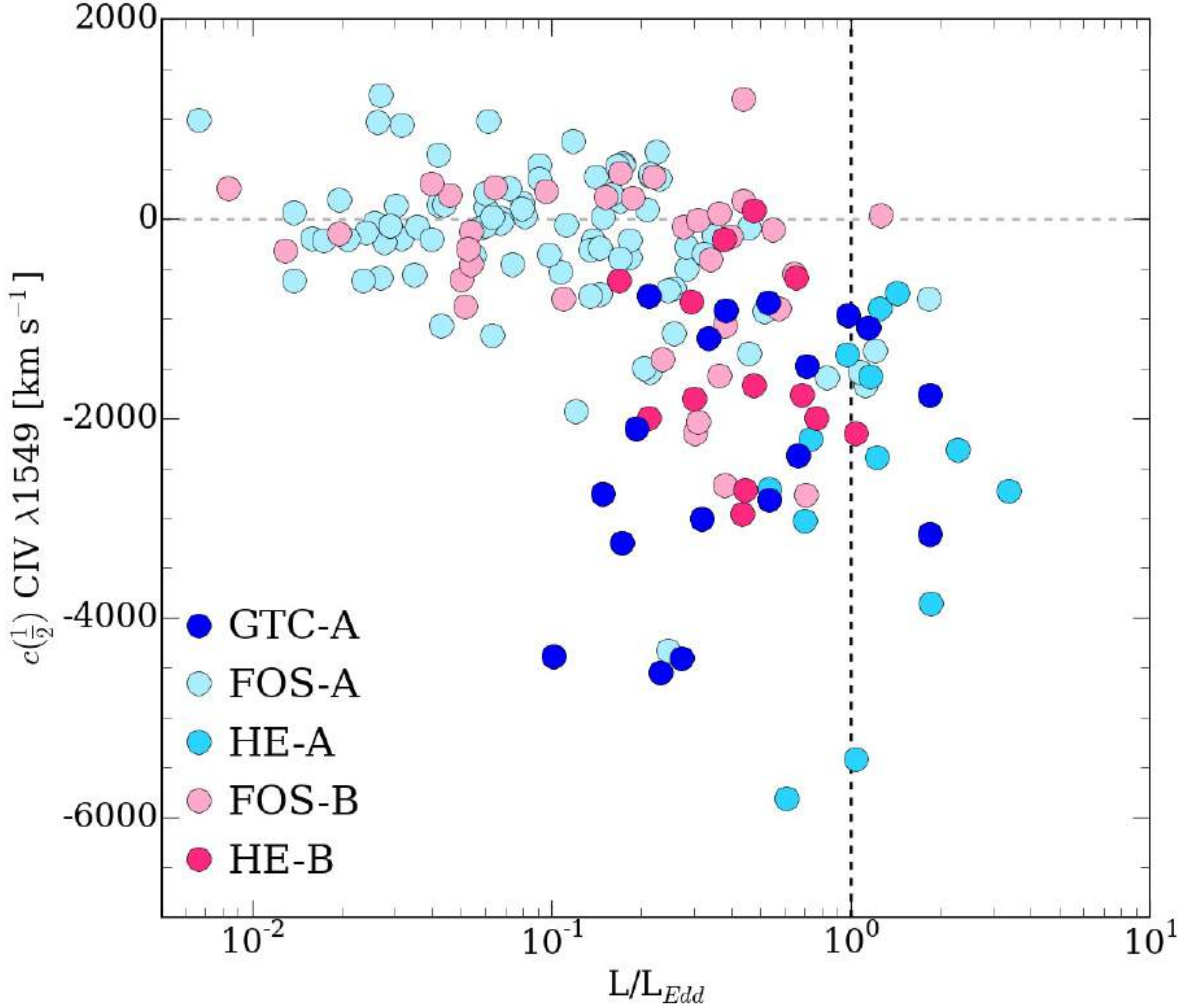
CIV λ1549 outflows and the Eddington ratios

Considering two samples (FORS VLT+HE) with Pop. A and B soures (Marziani & Sulentic 2014; Sulentic+ 2004, 2006, 2007; Marziani+ 2009), we find a strong tendence to the Pop. A sources to show CIV outflows, specially the at **GTC sample**.



CIV λ1549 outflows and the Eddington ratios

Moreover, the Pop. A sources tend to show high luminosities and Eddintong ratios.



Conclusions

- 4DE1 criteria are good in the selections of highly accretor quasars (type 1 AGNs)

- Blueshift components contribute more than 40% of the flux in 65% of our sources

- BLR radii computed with the photoionization method are somewhat smaller than the radii derived from reverberation maping scaling laws. And then, the black hole mass is larger.

- We confirm that these sources show a tendence to have high Eddington Ratios