LOW REDSHIFT BAL QSOs IN THE EIGENVECTOR 1 CONTEXT

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ABSTRACT

We attempt to characterize the geometry of Broad Absorption Line (BAL) QSOs by studying a low redshift sample of 12 sources. We find that the majority of these sources are Population A quasars as defined in Sulentic et al. (2000a, broad $\text{H}\beta$ FWHM $\leq 4000$ km s$^{-1}$). A possible correlation between terminal velocity and absolute $V$ magnitude suggests that the bolometric luminosity to black hole mass ratio $L_{\text{bol}}/M_{\text{BH}}$ is a governing factor with classical BAL sources showing the highest values. $\text{Civ} \lambda 1549$ emission in classical BAL sources shows a profile blueshift that supports a disk wind/outflow scenario with a half opening angle of $\lesssim 50^\circ$. Observation of “secondary” mini-BAL features in the $\text{Civ} \lambda 1549$ emission profile motivates us to model BALs with an additional component that may be involved with the BLR outflow and co-axial with the accretion disk.

Key Words: QUASARS — GALAXIES: ACTIVE — LINES: ABSORPTION — LINES: EMISSION

1. INTRODUCTION

Type 1 Active Galactic Nuclei (AGNs) apparently show three kinds of associated absorption features (here we focus on $\text{Civ} \lambda 1549$ as a characteristic high ionization line, HIL).

1. Narrow absorption lines (NALs) are the most common and are accepted as “associated” (e.g., Vestergaard 2003) (1) if they lie within $\pm 5000$ km s$^{-1}$ of the $\text{Civ} \lambda 1549$ emission line centroid, (2) if the rest frame equivalent width is between 0.5 and $\approx 4.0$ Å, (3) if the line width is no more than a few 100 km s$^{-1}$ (or alternatively the $\text{Civ} \lambda 1549$ doublet is resolved in absorption), and/or (4) if the lines are variable in intensity (Richards et al. 1998, 2001, Brandt et al. 2000, Ganguly et al. 2001, Vestergaard 2003, Wise et al. 2004).

2. Broad absorption lines (BALs) are thought to occur in 15 % - 20 % of AGNs (Hewett & Foltz 2003, Reichard et al. 2003) and generally show blueshifted troughs with velocity widths of several tens of km s$^{-1}$ and equivalent widths of several tens of Å. Terminal velocities in these broad features are measured in tens of thousand km s$^{-1}$.

3. Absorption features with intermediate properties (FWHM few thousand km s$^{-1}$, EW $\sim 5 - 10$ Å and sometimes variable) are called “mini-BALs” and may be even rarer than BALs (Jannuzi et al. 1998, Narayan et al. 2004). It is tempting to relate mini-BALs to BALs because they show blueshift velocities up to 50000 km s$^{-1}$, overlapping the BAL range, although there are arguments against a close connection (e.g., Narayan et al. 2004). However, mini-BALs are regarded as intrinsic (i.e., due to gas physically close to, and dynamically affected by the active nucleus central engine) absorption features, and not just as “associated” like NALs, which could be also due to distant gas). In this paper we consider BAL and mini-BAL phenomenology in low redshift quasars, while only occasional consideration will be given to NALs.

The discovery of BAL and mini-BAL QSOs has always been biased toward AGNs with high enough redshift to bring the most prominent UV resonance lines (e.g., $\text{Civ} \lambda 1549$, $\text{Mgii} \lambda 2800$) into the visible spectrum. IUE ($\sim 1978$) and HST ($\sim 1990$)
made it possible to observe the UV rest frame in low-$z$ AGNs resulting in the identification of several low $z$ sources showing BALs and mini-BALs (Turnshek et al. 1988; Boroson & Mevers 1992; Barlow et al. 1997; Januzzi et al. 1998).

One advantage of low redshift sources involves the possibility of a reliable determination of the quasar rest frame from optical emission lines or, in a few cases, host galaxy measures. An accuracy $\Delta z \leq 0.001$ can be achieved from [OIII]λ5007 or the peak of the narrow component of Hβ.

Another advantage stems from our ability to interpret the sources in the context of the Eigenvector 1 (E1) parameter space (Sulentic et al. 2000b). E1 tells us that AGN optical and UV emission line phenomenology is not randomly dispersed around an “average” spectrum. We identified four parameters that provide optimum discrimination between the various classes of broad line emitting AGNs. The three emission line parameters are: (1) FWHM of the Hβ broad component ($H\beta_{BC}$), (2) R$_{FeII}$ = W(FeII λ570)/W($H\beta_{BC}$) and (3) $C(1/2) = \text{profile centroid displacement of CIVλ1549 at half maximum}$. They are supplemented by (4) $\Gamma_{\text{soft}}$, the soft X-ray photon index. If we think of E1 as an H-R diagram for quasars then we find a principal occupation or main sequence for the majority of low redshift sources. The sequence ranges from radio-quiet (RQ) narrow line Seyfert 1 (NLSy1) sources with narrowest FWHM($H\beta_{BC}$), strongest R$_{FeII}$, largest CIVλ1549 blueshift and strongest soft X-ray excess to lobe-dominated radio-loud (RL) sources with the broadest $H\beta_{BC}$ profiles, weakest R$_{FeII}$ and no soft X-ray excess or CIVλ1549 blueshift. The main E1 occupation/correlation sequence is likely to be driven by the Eddington ratio (Marziani et al. 2003a, 2003b; Marziani et al. 2004). Analysis of the optical E1 parameters support the idea that Pop. A sources are radiating at higher Eddington ratio than Pop. B (Boroson & Green 1992; Pounds et al. 1995; Marziani et al. 2003b).

Further support comes from CIVλ1549 and other UV HIL resonance lines which show evidence for a wind or outflow in Pop. A sources.

2. SAMPLE DEFINITION

Defining a large, complete sample of low-$z$ BAL QSOs is impossible with present data. We select BAL + mini-BAL (BALnicity index $\approx 0$ km s$^{-1}$; Weyman et al. 1991) QSOs using the following two criteria: (1) FWHM(CIVλ1549)$_{\text{abs}} \geq 2000$ km s$^{-1}$, (2) and $W$(CIVλ1549)$_{\text{abs}} \geq 4$ Å. This results in negligible overlap with high and low $z$ NAL samples (e.g., Richards et al. 1999; Brandt et al. 2000; Ganguly et al. 2001; Vestergaard 2003). We consider objects with magnitude $m_V \leq 16.3$ and redshift $z \leq 0.5$ and find 12 sources which include: (a) AGNs identified in NED as BAL QSOs (with the exception of PG 1416--129 which does not show absorption in HST spectra; see Green et al. 1997), (b) BAL QSOs in Turnshek et al. (1997) selected on the basis of weak [OIII]λ4959,5007 emission (4 objects), (c) soft X-ray weak PG QSOs with $W$(CIVλ1549)$_{\text{abs}} \approx 5$ Å from Brandt et al. (2003), with the exception of PG 1126--041. We also visually inspected the HST-FOS archival spectra that included CIVλ1549 (as retrieved by Bachev et al. 2004) and found no additional sources satisfying our selection criteria.

Our conditions are less restrictive than those of Weyman et al. (1991) since we consider BAL sources with shallow absorption troughs and with FWHM(CIVλ1549)$_{\text{abs}} \geq 2000$ km s$^{-1}$; Weyman et al. (1991) exclude source with absorption trough $\lesssim 10\%$ of the adjacent continuum. We do not consider as BAL quasars sources with absorption of any depth but with width $\lesssim 2000$ km s$^{-1}$ (notable examples include Aki 564 and IRAS 04505--2958; Bechtold et al. 2002; Crenshaw et al. 2002).

Table I identifies the objects in our sample (Column 1: IAU code; Column 2: common name), and provides the apparent visual magnitude (Col. 3; notable examples). The objects reported with two decimal digits are new observations; see 631, the absolute V magnitude (assuming $H_0 = 75$ km s$^{-1}$ Mpc$^{-1}$, $\Omega_M = 0.3$, and $\Omega_{\Lambda} = 0.7$; Col. 5), the heliocentric redshift and its associated uncertainty (Col. 4; see also the beginning of Col. 7), the date of optical spectroscopic observations (Col. 6), the universal time at the beginning of the exposure (Col. 7) and the exposure time in seconds (Col. 8). The last column (Col. 9) provides...
the acronym of the observatory where the data have been collected. We use the term “low-z QSOs” for all of our objects even if a few objects are at or below the formal boundary between Seyferts and QSOs ($M_B \approx -22.1$).

3. OBSERVATIONS & DATA ANALYSIS

3.1. Observations

Optical Photometric Observations B, V, Rc, Ic observations have been obtained (16 and 17/02/2001) with the 2.0m RC telescope of the Bulgarian National Astronomical Observatory “Rozhen”, equipped with a Photometrics 1024×1024 CCD camera. Landolt (1992) standards were observed before and after every source. Apparent V magnitudes are given in Table 1. The error of our magnitudes is ±0.05 mag in all bands.

Optical Spectroscopic Observations Data used in the present study are part of a large sample of spectroscopic observations covering the Hβ spectral region (Marziani et al. 2003a). The dataset covers 215 AGNs with resolution typically around 4Å FWHM and S/N (in the continuum near Hβ) usually ≥ 20. Data on individual observations used in this paper are reported in Table 1.

UV Spectroscopic Observations UV observations are HST/FOC with high resolution grating (yielding a precision of ≈200 km s$^{-1}$), and STIS medium-resolution spectra covering CIVλ1549. FOS data were re-calibrated with the latest STPOA processing scripts using IRAF/SDS. This takes into account systematic errors in the wavelength scale of the FOS/BL data which were not properly considered until recently (e.g., Kerber & Rosa 2000). Several IUE observations were also included with correspondingly lower precision $\Delta_{\text{UV}} \sim 1000\text{km s}^{-1}$. In the case of Mrk 231 IUE data were included because only a G150L HST/FOS observation was usable. Table 2 provides a log of the UV archival observations employed in the present paper. Col. 2 lists the telescope and the camera; Col. 3 the grating. Col. 4, 5, 6 provide date, universal time and exposure time respectively. Col. 7 identifies the data-set.

3.2. Optical and UV Data Analysis: FeII opt and FeII UV emission

Optical and UV observations were analyzed following Marziani et al. (1996), 2003b, Hβ and CIVλ1549) and Sulentic et al. (2000a). The wavelength and flux-calibrated spectra were shifted to the rest frame and then continuum and FeII subtracted. FeII subtraction used a scaled and broadened template based on observations of FeII strong I Zw 1. It is now possible to define a better template for both optical and UV FeII emission (between 1400 Å and 1800 Å). The optical one is almost identical to the one used in Boroson & Green (1992) but is based on a higher resolution spectrum. Our FeIIUV template comes from two post-COSTAR I Zw 1 observations, the first covering the G130H spectral range (dataset Y26C0204T - 13-Feb-1994) and the second covering the G190H range (dataset Y26C0103T - 14-Sep-1994). The template agrees with a theoretical model computed for hydrogen density $n_H = 10^{12} \text{cm}^{-3}$, and ionizing photon density $log(\Phi_H) = 17.5 \text{cm}^{-2} \text{s}^{-1}$ (Verner et al. 1999). This may be the most appropriate case for the overall low ionization level observed in the spectra of NLSy1s like I Zw 1 (Marziani et al. 2001). It also agrees satisfactorily with the template of Vestergaard & Wilkes (2001).

The continuum level was defined in spectral regions at ≈1450 Å and 1750 Å, where no emission features were appreciable. For three sources with strong FeIIUV emission (PG 0043+038, IRAS 07589+6508, and PG 1700+518) the final continuum level was set after FeIIUV subtraction.

4. RESULTS

4.1. Hβ and CIVλ1549 Profile Analysis

Rest-frame CIVλ1549 and Hβ spectral regions are shown in Fig. 1 for the entire sample. The rest frame was assumed to be equivalent to the redshift of the narrow optical emission lines except for one source where an HI measure was available (see notes to Table 3 for references; if no reference is given then z determination was estimated in this study). We found no evidence for a significant discrepancy between [OIII]λ4959,5007 measurements and other narrow lines (including the peak of Hβ which was also used as an [OIII]λ5007 surrogate when [OIII]λ5007 was not detected: §1.2).

Cleaned CIVλ1549$_{BC}$ and Hβ$_{BC}$ profiles are shown in Fig. 2 and Fig. 3. The Hβ$_{BC}$ profile is emphasized by a high-order spline following Marziani et al. (2003a). Table 4 lists the measured rest frame parameters for the Hβ spectral region: W(Hβ$_{BC}$), R$_{FeII}$, FWHM(Hβ$_{BC}$) and FWHM(FeII λ4570) with uncertainty at a $2\sigma$ confidence level. Col. 2–4 of Table 4 list the parameters for the emission component of CIVλ1549: peak $v_t$, equivalent width, and FWHM(CIVλ1549) after FeIIUV correction, respectively. In addition we report: radial velocity at minimum trough (Col 5), maximum blueshift velocity of the absorption (i.e., the terminal velocity, Col. 6), the equivalent width (Col. 7),
FWHM of the principal broad absorption component (Col. 8), and BALnicity index as defined by Weyman et al. (1991, Col. 9). All values are for the source rest frame. Errors in EW and FWHM are usually ≈ 20%. Radial velocity measurements have a similar uncertainty, unless noted. BALnicity index uncertainty is estimated to be ± 500 km s$^{-1}$ at a 2σ confidence level. Some values with extremely asymmetric error bars have uncertainties indicated in the Table.

Fig. 2 shows the continuum and Feii subtracted CIVλ1549 and Hβ profiles for BALs while Fig. 3 shows the spectra of the 4 mini-BALs. Fig. 4 shows the assumed unabsorbed profile estimated by reflecting the red unabsorbed side of the emission profile onto the blue absorbed side. This procedure works especially well for PG 1351+640 and PG 1411+442 where the mini-BAL troughs appear to be displaced onto the blue absorbed side. This procedure works well for our source sample is log $M$ ≈ 8.1 in solar units (following Marziani et al. 2003; Sulentic et al. 2002). There seem to be no correlation with black hole mass. The dependence on mass in the E1 plane in Fig. 4 was computed for a fixed value of $M_{BH}$≈10$^8$ M$_\odot$ (as in Marziani et al. 2001). This $M_{BH}$ value is used because the average virial $M_{BH}$ for our source sample is log $M$ ≈ 8.1 in solar units (following Marziani et al. 2003; Sulentic et al. 2002). There seem to be no correlation with black hole mass. The dependence on mass in the E1 diagram is rather weak, and the dispersion of log $M$ ≈ 0.6 is less than the mass difference needed to have effects comparable to the ones due to orientation ($\Delta$ log $M$ ≈ 1, at least). However, sources with larger $M_{BH}$ also tend to displace upward (i.e., toward larger FWHM(H$\beta_{BC}$); Zamanov & Marziani 2002). The location of the BAL QSOs in the optical E1 plane can be considered only as suggestive of larger inclination.

An orientation indicator appears to be emerging for the RQ Pop. A quasars as a low inclination blue outlier source population (showing a significant [OIII]λ4959,5007 blueshift; Zamanov et al. 2002; Marziani et al. 2003b). Blueshifts of several hundred km s$^{-1}$ are observed in [OIII]λ4959,5007 for
some NLSy1 (extreme E1 Pop. A sources), especially in sources with unusually weak [OIII]λ5007 (Zamanov et al. 2002; Marziani et al. 2003). Blue outliers may involve the youngest type 1 sources (Sanders et al. 1988; Zamanov et al. 2002). None of the 12 blue outliers with available UV data show BAL properties, suggesting that BALs are not observed pole-on. The mini-BAL phenomenon appears to occur over a wider range of inclination angles if our small sample can be taken as indicative. It is worth noting that NAL sources show no occupation restriction in E1—they are found everywhere.

4.2.1. E1 Outliers: Mrk 231 and IRAS 07598+6508

We first point out that FWHM(Hβopt)≈FWHM(FeIIopt) within the uncertainty for all/most pop. A sources in our sample of ≈ 300 low z AGN (Marziani et al. 2003a). The only two convincing exceptions are Mrk 231 and IRAS07598+6508. Our E1 sample studies suggest that HβBC in Pop. A sources can usually be modeled with a symmetric Lorentzian function (Sulentic et al. 2002). Fig. 2 shows that Mrk 231, IRAS 07598, and perhaps a few other sources, show a blue asymmetric Hβ profile that could be modelled as a separate strongly blueshifted component. The presence/absence of this extra component will affect FWHM measures for HβBC (Fig. 3). If one considers only the unshifted component with width comparable to FWHM(FeIIopt) the two sources move into the region with FWHM(HβBC)<4000 km s^{-1}. These two sources are among the strongest FeIIopt emitters in our sample. If we consider only the FeII-like Lorentzian component of HβBC in deriving the RFeII parameter we find a large increase to ≈5 and 3 for Mrk 231 and IRAS 07598+6508 respectively. If they are now compared to the rest of the sample they will show the largest values of RFeII and will lie close to the upper FWHM boundary for NLSy1s. The blueshifted line component roughly corresponds to the blueshifted CIV1549 emission component and it is not unreasonable to argue that part of the Balmer emission could arise in the postulated wind/outflow where most of the CIV1549 is produced. Alternatively, the blueshifted HβBC residual could be associated to a nuclear Starburst. A similar interpretation is possible for PG 0043+039 although the blueward asymmetry in the HβBC profile is below half maximum.

4.3. A Terminal Velocity-Luminosity Correlation?

Four out of five BAL QSOs with highest terminal velocities (v_T ≲ 15000 km s^{-1}) are Pop. A sources which have higher L/Edd in general (Marziani et al. 2003). Indeed, in our sample we find evidence for a correlation between terminal wind velocity and absolute V magnitude (Fig. 3). This is expected if the Eddington ratio is governing the wind/outflow as, for example, in the case of radiation pressure driven winds (Laor & Brandt 2002).

The highest terminal velocities are likely possible only for Pop. A objects where we see the blueshifted CIV1549 emission component. However the conclusion that BAL QSOs are exclusive to Pop. A is challenged by the discovery of radio-loud BAL QSOs in the FIRST survey (Becker et al. 2000), as well as by the presence in our sample of the Pop. B source PKS 1004+13 (FWHM(HβBC)≈7000 km s^{-1}) that was identified as the first radio-loud BAL QSO relatively recently (Wills et al. 1999).

The terminal velocity, in the case of a pressure driven wind, is v_T ∝ \sqrt{L/L_{Edd}}. Considering the classical BAL QSOs in our sample, we have

\[ v_T \approx \frac{\text{FWHM(CIV)}}{2} \sqrt{\frac{L}{L_{Edd}}} \]

(c.f. Laor & Brandt 2002). If we assume that the force multiplier f_M is a function of ionization parameter U (defined as the ratio of the photon density to electron density), well approximated by f_M ≈ U^{2.55}−0.5 (Arav et al. 1994), we can write the terminal velocity as

\[ v_T \approx 10^4 \text{FWHM(CIV)}_{1000}U^{-0.5}\left(\frac{L}{L_{Edd}}\right)^{\frac{1}{2}} \text{km s}^{-1}, \]

where FWHM(CIV1549) is in units of 1000 km s^{-1}. FWHM(CIV1549)/2 can be taken as a rough estimate of the initial injection velocity in the case of a radial flow. If we assume: (1) that the most extreme pop. A sources radiate close to the Eddington limit while Pop. B sources typically have L/L_{Edd} ≈ 0.1, and (2) that a proper FWHM(CIV1549) value is 4000 km s^{-1} and 6000 km s^{-1} for Pop. A and B respectively, we find v_T ≈ 400000U^{-1/4} km s^{-1} (Pop. A, U ≳ 0.01) > 200000U^{-1/4} km s^{-1} (Pop. B, U ≲ 0.5). Simple radiation-driven wind considerations are therefore consistent with the existence of a Pop. B BAL source and are predicting systematically lower v_T, as implied by the observations. The terminal velocity in RL BAL QSOs may also be systematically lower than in RQ BAL QSOs (Becker et al. 2000) as is true for our single example. Therefore, a Pop. B source does not necessarily undermine the idea of a critical Eddington ratio accounting for the Pop. A-B dichotomy.

At this point in time the evidence suggests that RL or RQ Pop. B BAL sources are rare.
The NLSy1-like properties (FWHM(Hβₜₚ)≈ 2100 km s⁻¹ and strong Fe₅₇7 motivated our skepticism about the RL designation for this source [Becker et al. 1997]. It is now known that it probably suffers from strong optical extinction [Najita et al. 2000] and is RQ. This warrants caution about other claimed RL BALs especially if they show Pop. A characteristics (see [Brotherton et al. 1998 Sulentic et al. 2001]). PKS 1004+13 is a genuine RL pop B source, and unless many more are found, one should consider it as a rare RL BAL source.

5. DISCUSSION

5.1. A Simple Model for Interpretation of the CIV\textalpha 1549 Profiles

Our results, coupled with the main constraints set by much earlier work (see reviews by [Turnshek 1986 Crenshaw et al. 2003]), lead to a simple geometrical and kinematical model (Fig. 7). We ascribe the high-ionization line emitting BLR to a wind as is now widely accepted. An immediate inference from a fully blueshifted emission component involves a radial flow (v/vₘ₀ ≳ 1) with an opening angle ≲ 90° if BALQSOs are those QSOs viewed near the maximum possible orientation (i ≲ 45°). The BAL region might extend in a conical corona of divergence angle ≲ 10° (which would include our line of sight; Fig. 7). The absorption profiles are furthermore consistent with a radiation driven wind launched at roughly the outer radius of the BLR because the emission component is only marginally “eaten away” by the BAL. This appears to be the case for the sources in this paper as well as for many BAL QSOs in high-z samples (e.g. [Korista et al. 1993]).

While this scheme is fully consistent with a “standard BAL QSO model” that has emerged over the course of more than 15 years of research, the observation of secondary absorption components may require an additional element. We suggest that whenever a secondary absorption is present we may be observing an axial region covering all of the continuum-emitting region and part of the BLR as well. This property is needed to explain the depth of the absorption which implies f_e \gtrsim 0.5. This axial region may involve a cylindrical sheet of absorbing gas with different physical properties than the BAL region. However, it appears to share the BLR flow because the absorption is located close to the center of the CIV\textalpha 1549 emission component in all three cases presented here. The narrower absorption profile may result from a restricted viewing angle ≈50°. It is important to stress that a shell of absorbing material which could provide an adequate f_e is not viable in the geometrical context of our model because of the relatively narrow absorption. A flow spiralling outward i.e., with a significant rotational component may also produce the secondary absorption although it seems again difficult to explain the absorption depth.

The cylindrical sheet may have a straightforward physical explanation if it is connected with axial flows. A two-fluid model for relativistic outflows includes a fast relativistic beam surrounded by a slower, possibly thermal, outflow with a mixing layer between the beam and the jet (e.g. [Lobanov & Roland 2004]). A black hole with specific angular momentum significantly different from zero, or even approaching the maximally rotating case (a/M \approx 0.998), is required for driving relativistic, radio-emitting jets ([Blandford & Znajek 1977]. The most straightforward evidence for BH with a/M \gtrsim 0, apart from the existence of radio jets, comes from Fe Kα profile shape and variations in a RQ Pop. A source, MCG –06–30–15 [Sulentic et al. 1998], as well as from energy considerations for rapidly-varying X-ray sources ([Forster & Halpern 1996] which are again RQ Pop. A sources. In a scenario where some NLSy1s and, at least, some other Pop. A sources are young/rejuvenated quasars [Mathur 2000; Sulentic et al. 2000a], they may have experienced one of the rare accretion events leading to a consistent increase of the black hole angular momentum (unlike mass, black hole angular momentum can reverse and decrease through BH mergings and accretion; [Gammie et al. 2004 Hughes & Blandford 2003]. Accretion events leading to refueling of the central BH are expected to be driven by mergers or strong interactions between galaxies. These give rise to an enhancement in FIR emission (observationally thought to reflect enhanced star formation activity (physically; [Canalizo & Stockton 2002 Lipari et al. 2004, and references therein). Three sources in our sample are Ultra-Luminous IR sources (log L_{FIR} \gtrsim 12 in solar units). They are the two E1 outliers as well as PG 1700+518. It is interesting to note that, on the basis of the L_{bol}/M_{BH} dependence shown in Fig. 4 the observed R_{FIR} for Mrk 231 and IRAS 07598+6508 would require highly super-Eddington accretion unless the accreting object is a Kerr black hole. The only radio loud source in our sample of BAL QSOs (PKS 1004+13) is one of the 3 sources with a deep secondary absorption. As a final speculation, we therefore suggest that the inner cylinder may be observed only in sources whose central black hole has a significant spin.

The proposed axial sheet of gas is actually a vari-
ant of the model proposed by Elvis (2000) to explain the occurrence of BAL and NAL. Bent flow lines seen at large viewing angles, or along the flow, could give rise to NAL and BAL respectively. This would require that the flow be observable at large inclinations ($i \to 90^\circ$) which is not supported by the properties of the CIV$\lambda 1549$ profiles in our sample.

5.2. From Low-z to High-z BAL QSOs

It is interesting to consider the CIV$\lambda 1549$ emission properties of the few high-z BAL QSOs for which a rest frame can be determined. Table C lists all cases that could be found in the literature. Following the source name and redshift we list: FWHM(H$\beta_{BC}$) (Col. 3), qualitative evaluations of the strengths of Feii$\lambda 5017$ and [OIII]$\lambda 4959,5007$ respectively (Col. 4-5), as well as radial velocity shift $\Delta v_r$ is given in the footnotes). FWHM(H$\beta_{BC}$) and $\Delta v_r$ are given in the quasar rest frame. We see that CIV$\lambda 1549_{BC}$ is most often shifted by $\geq 1000$ km $s^{-1}$ and overall the properties are more consistent with Pop. A than Pop. B sources. This provides some support for the assumption that our sources are low redshift analogues of the larger high redshift BAL population, even if our small sample cannot sample all of the rich high-z BAL QSO phenomenology. High-z BAL QSOs studied by Hartig & Baldwin (1986) show large Si$\pi$$\lambda 1892/C$iii$\lambda 1909$, strong Feii$\lambda 1600$, low W(CIV$\lambda 1549$) in emission and large blueshifts with respect to Mgii$\lambda 2800$. These are also typical properties of Pop. A sources (Zamanov et al. 2002, Bachev et al. 2004).

5.3. BAL QSOs and the General QSO Population

The model sketched in Fig. 4 also helps us to understand the relationship between BAL QSOs and general Pop. A of quasars. Blueshifted CIV$\lambda 1549$ emission profiles have been known for a long time (Gaskell 1982) and, at low $z$, the most extreme examples are observed in prototype NLSy1 sources like I Zw 1. Systematic CIV$\lambda 1549$ blueshifts are also observed in the larger domain of Population A sources that include NLSy1s (Sulentic et al. 2000b). The HIL CIV$\lambda 1549$ properties (and corresponding LIL H$\beta_{BC}$ properties) were interpreted as arising in a HIL wind (from a LIL emitting accretion disk: Marziani et al. 1996, Dultzin-Hacyan et al. 2000). If a source is observed almost pole-on the outflow gives rise to a fully blueshifted CIV$\lambda 1549_{BC}$ profile. At the same time we observe the narrowest H$\beta_{BC}$ profiles implying that the outflow has a major velocity component perpendicular to the disk (for a fixed $L_{bol}/M_{BH}$; Marziani et al. 2001). This is consistent with the properties of e.g., I Zw 1 or Ton 28 with respect to the generality of Pop. A sources. The blueshift of CIV$\lambda 1549_{BC}$ is smaller if the wind system is observed at larger angles. As the inclination increases, a rotational component from the disk may further reduce the CIV$\lambda 1549_{BC}$ profile shift. However, since we still observe an almost fully blueshifted CIV$\lambda 1549_{BC}$ in several BAL QSOs of our sample, it seems unlikely that the inclination and the half-opening angle of the radial flow exceed $\approx 45^\circ + 10^\circ \approx 55^\circ$.

One must also take into account that $v/v_{rot}$ is expected to be a function of $L_{bol}/M_{BH}$, and hence to increase with $R_{FeII}$ (Marziani et al. 2001). This lowers the likelihood of observing a large CIV$\lambda 1549_{BC}$ blueshift as one goes from population A3 spectral types to B following the definition of Sulentic et al. (2002). BAL QSOs with CIV$\lambda 1549$ profiles like the PG 1700-518 one are therefore most likely Pop. A sources observed at extreme Eddington ratio and at higher inclination. Their pole-on counterparts may be sources like I Zw 1.

The absence of any significant absorption at the CIV$\lambda 1549_{BC}$ line centre may be telling us that there is no significant spin in the central engines. If black hole angular momentum is different than 0 we can expect to see the “central” absorption observed in BAL QSOs at the blue edge of the CIV$\lambda 1549_{BC}$ emission profile as a detached mini-BAL. Such features may be rare and of modest equivalent width.

6. CONCLUSION

This work supports the standard model for BAL QSOs (i.e., a radiation-driven wind flowing out at the edge of the BLR), which directly accounts for most of the absorption/emission line properties observed in our small low-z sample. The E1 correlations allow us to ascribe the most extreme BAL phenomenology to large Eddington ratio sources, and at the same time to account for the existence of BALs in sources radiating at relatively low Eddington ratios ($\approx 100$). In the context of the E1 scenario it also suggests an axial structure associated with vertical ejection contributes to the absorption, a suggestion requiring further testing.

This paper emphasizes the importance of having full coverage of the rest frame spectrum from 1500 Å to the Balmer lines. In this case the data allow to accurately determine the quasar rest frame and to use the E1 parameter space plus a simple geometric model to interpret new results. This approach is now becoming possible for intermediate redshift quasars.
(1 \lesssim z \lesssim 2) \text{ where IR spectra preserve access to the region of H}_\beta.\]

Properties of Individual Sources

PG 0043+039 \equiv J00457+0410 – shows a FIR excess but only a marginal outlier in the E1 plane. The BALnicity index reported goes to 0 because of the placement of the continuum, which is likely to be more accurate in this study because of the Fe_\text{ii} UV subtraction, even if the absorption trough remains evident.

IRAS 07598+6508 \equiv J08045+6459 – This intriguing object shows a FIR excess, and its location in the E1 plane is peculiar. It is interesting to note that FWHM(H_\beta_{BC}) \approx 5000 \text{ km s}^{-1} \gg FWHM(\text{Fe} \text{ii}) \approx 2000 \text{ km s}^{-1}. The good S/N ratio and the strength of Fe_\text{ii} opt emission, along with the large W(H_\beta_{BC}) make this result especially striking (see §4.2.1 and Fig. 5).

PG 1001+054 \equiv J10043+0513 – Source PG 1001+054 has a fairly uncertain absorption trough; could be a detached (or almost detached) mini-BALs. The mini-BAL interpretation is supported by the location of this source in the E1 diagram (Fig. 4). There is no evidence of spectral variability from the three spectra employed in this study.

PG 1004+130 \equiv J10074+1248 – The brightest radio loud BAL QSO, recognized by Wills et al. (1999). The CIV_{\lambda 1549} absorption and emission properties resemble those of the Pop. A BAL QSO with BALnicity index \gg 0, although this object is a lobe-dominated radio loud quasar, with FWHM(H_\beta_{BC}) \approx 7000 \text{ km s}^{-1}.

PG 1126-041 \equiv J11292-0424 – A bona-fide mini BAL-QSO.

Mrk 231 \equiv J12562+5652 – HST/FOS observations with grism G190H produced only noisy spectra due to the strong internal extinction. Mrk 231 is well known for the prototypical ULIRG and mixed/Starburst AGN properties, and the SED shows an impressive FIR excess over the typical RQ SED. The useful spectra were taken with the low dispersion grism. The BALnicity index for CIV_{\lambda 1549} is close to 0 km s\(^{-1}\); however, this should be viewed with some care due to the heavy internal reddening (A_\text{V} \approx 2; Lipari et al. 1994). FeI\text{ii} emission is not well reproduced by the template, but this is more likely to be due to the heavy internal reddening rather than intrinsic differences with the I Zw 1 template. Since we modelled the observed FeI\text{ii}
\[ \lambda 4570 \] blend (uncorrected for internal reddening), the actual \( R_{\text{FeII}} \) could be somewhat higher than reported (but not dramatically so).

PG 1351+640 \( \equiv J13532+6345 \) and PG 1411+441 \( \equiv J14138+4400 \) – They are mini-BAL QSOs, with the absorption eating up the \( \text{CIV}\lambda 1549 \) line core at \( \Delta v_r \approx -5000 \text{ km s}^{-1} \) (less than the emission blue wing zero intensity width). \( W(\text{CIV}\lambda 1549) \) has been estimated mirroring the red side of the profile, agrees very well with the remaining emission blue wing at \( \Delta v_r \lesssim -5000 \text{ km s}^{-1} \) (§3.2).

Mrk 486 \( \equiv J15366+5433 \) – Mrk 486 shows a similar absorption pattern as in PG 1351+640 and PG 1411+441 in a 1984 IUE spectrum which is apparently no longer present in more recent (1993) HST/FOS observations (see Fig. 3 where the profiles observed at different epochs are superimposed). However, the relatively poor S/N of the HST spectrum makes it difficult to ascertain whether the change in the mini-BAL absorption feature is real.

PG1552+085 \( \equiv J15547+0822 \) – This source shows a BALnicity index \( \approx 0 \text{ km s}^{-1} \). We include this source among the classical BAL QSOs because of its wide (albeit somewhat shallow) absorption trough. An IUE spectrum has been published by [Turnshek et al. 1997], and retrieved by us. The new STIS spectrum confirms the BAL nature of the source, even if the feature, for \( \text{CIV}\lambda 1549 \) is shallower and affected by noise since \( \text{CIV}\lambda 1549 \) is close to the edge of the STIS covered spectral range.

PG 1700+518 \( \equiv J17014+5149 \) – PG 1700+518 is the prototype low redshift BAL QSO. The UV spectral properties are remarkably similar to the ones of Mrk 231, PG 0043+054, and IRAS 0759+6459.

PG 2112+059 \( \equiv J21148+0607 \) – This objects has a \( \text{CIV}\lambda 1549 \) emission profile similar to the one of I Zw 1, and we observe a fully detached absorption trough. Optical lines are significantly broader than in NLSy1s, but the object still lies within the Pop. A area.

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| IAU name         | Object name       | $m_V$   | $z$       | $M_V$    | Date   | UT     | ET     | Obs.    |
|------------------|-------------------|---------|-----------|----------|--------|--------|--------|---------|
| J00457+0410      | PG 0043+039       | 16.0    | 0.3850 ± 0.0010 | -24.84   | 09/10/1994 | 02:27  | 6000   | ESO     |
| J08045+6459      | IRAS 07598+6508   | 14.31   | 0.1488 ± 0.0001 | -24.42   | 22/02/1991 | 02:18  | 2500   | KPNO    |
| J10043+0513      | PG 1001+054       | 16.21   | 0.1610 ± 0.0010 | -22.77   | 19/02/1991 | 06:52  | 3600   | KPNO    |
| J10074+1248      | PG 1004+130       | 15.24   | 0.240 ± 0.001   | -24.57   | 21/04/1990 | 05:10  | 3600   | BG      |
| J11292−0424      | PG 1126-041       | 14.69   | 0.0560 ± 0.0001 | -22.00   | 19/02/1991 | 08:16  | 1800   | KPNO    |
| J12562+5652      | Mrk 231           | 13.60   | 0.0412 ± 0.0001 | -22.39   | 09/12/1994 | 09:14  | 3000   | SPM     |
| J13532+6345      | PG 1351+640       | 14.3    | 0.0822 ± 0.0001 | -23.26   | 19/02/1991 | 10:38  | 1800   | KPNO    |
| J14138+4400      | PG 1411+442       | 14.65   | 0.0896 ± 0.0005 | -23.03   | 19/02/1991 | 12:31  | 1800   | KPNO    |
| J15366+5433      | Mrk 486           | 14.8    | 0.0389 ± 0.0001 | -20.68   | 01/07/1995 | 05:50  | 2400   | SPM     |
| J15547+0822      | PG 1552+085       | 16.3    | 0.119 ± 0.001  | -22.03   | 17/02/1990 | 12:17  | 2400   | BG      |
| J17014+5149      | PG 1700+518       | 14.98   | 0.2899 ± 0.0007 | -25.24   | 30/04/1995 | 00:13  | 3600   | CA      |
| J17014+5149      |                  |         |           |          |        |        |        |         |
| J21148+0607      | PG 2112+059       | 15.8    | 0.46005 ± 0.00010 | -25.45   | 18/10/1990 | 01:43  | 2400   | KPNO    |
| J21148+0607      |                  |         |           |          |        |        |        |         |

*a* Solomon et al. (1997) HI 21 cm; optical determination suggests larger uncertainty (shifted by -300 km s$^{-1}$).

*b* Wills et al. 1999.

*c* Average value of Falco et al. (1999) and de Vaucouleurs et al. (1991) (RC3).

*d* Marziani et al. 1992.

*e* SIMBAD.

*f* Schmidt & Green (1983).
| IAU name       | Camera       | Grating    | Date      | UT   | ET (s) | Data Set   |
|---------------|--------------|------------|-----------|------|--------|------------|
| J00457+0410   | HST/FOS      | G190H/BL  | 28/10/1991| 04:36| 1315   | Y0RV0204T  |
| J08045+6459   | HST/STIS     | G140L     | 10/12/1998| 16:37| 2570   | O4YY18010  |
|               | IUE/SWP      | Low disp. | 28/09/1989| 03:38| 12840  | SWP37199   |
|               | IUE/SWP      | Low disp. | 17/12/1990| 18:54| 13200  | SWP40376   |
| J10043+0513   | HST/FOS      | G190H/RD  | 16/01/1997| 00:03| 1260   | Y38O0208T  |
|               | HST/FOS      | G190H/RD  | 26/12/1996| 17:27| 530    | Y33S0304T  |
| J10074+1248   | IUE/SWP      | Low disp. | 12/01/1986| 08:30| 19000  | SWP27517   |
|               | IUE/SWP      | Low disp. | 23/03/2003| 03:23| 2899   | 065EW03020 |
| J11292−0424   | IUE/SWP      | Low disp. | 05/01/1985| 12:05| 9900   | SWP53285   |
|               | IUE/SWP      | Low disp. | 01/06/1992| 07:31| 5400   | SWP44822   |
|               | IUE/SWP      | Low disp. | 01/06/1992| 12:19| 6600   | SWP44823   |
| J12562+5652   | HST/FOS      | G150L/BL  | 21/11/1996| 08:40| 770    | Y3GS0404T  |
| J13532+6345   | HST/FOS      | G190H/BL  | 05/09/1991| 10:41| 1500   | Y0P80306T  |
| J14138+4400   | HST/STIS     | G230L     | 12/02/2001| 01:23| 1200   | O65617010  |
| J15366+5433   | HST/FOS      | G190H/BL  | 15/11/1993| 02:56| 1440   | Y1EL0302T  |
|               | IUE/SWP      | Low disp. | 07/05/1984| 00:23| 51600  | SWP22932   |
| J15547+0822   | IUE/SWP      | Low disp. | 28/04/1986| 13:40| 10200  | SWP28237   |
|               | HST/STIS     | G230L     | 05/07/2003| 07:23| 900    | O6MZ4I010  |
| J17014+5149   | HST/STIS     | G230L     | 30/01/2001| 16:27| 1200   | O65619010  |
| J21148+0607   | HST/FOS      | G190H/RD  | 19/09/1992| 14:27| 2372   | Y10G0204T  |
|               | HST/FOS      | G270H/RD  | 19/09/1992| 16:07| 1690   | Y10G0205T  |
### TABLE 3

**Hβ_{BC} AND FeII**

| IAU name     | W(Hβ_{BC}) | R_{FeII} | FWHM(Hβ_{BC}) | FWHM(FeII λ4570) |
|--------------|------------|----------|---------------|------------------|
|              | (1)        | (2)      | (3)           | (4)              |
| J00457+0410  | 101 ± 11   | 0.74 ± 0.17 | 4000 ± 700   | 4300 ± 1000      |
| J08045+6459  | 77 ± 7     | 1.21 ± 0.19 | 5000 ± 400   | 2100 ± 300       |
| J10043+0513  | 93 ± 5     | 0.49 ± 0.11 | 1900 ± 300   | 1850 ± 300       |
| J10074+1248  | 37 ± 4     | <0.39      | 6700 ± 300   | ...              |
| J11292-0424  | 82 ± 8     | 0.78 ± 0.16 | 2300 ± 500   | 3100 ± 800       |
| J12562+5652  | 45 ± 15    | 1.78 ± 0.67 | 6600 ± 900   | ≈ 3000           |
| J13532+6345  | 34 ± 4     | <0.19      | 5900 ± 300   | ...              |
| J14138+4400  | 86 ± 4     | 0.36 ± 0.09 | 2600 ± 200   | 2600 ± 500       |
| J15366+5433  | 84 ± 4     | 0.40 ± 0.08 | 1800 ± 200   | 1850 ± 500       |
| J15547+0822  | 54 ± 5     | 1.40 ± 0.21 | 2300 ± 300   | ...              |
| J17014+5149  | 55 ± 5     | 0.98 ± 0.13 | 2200 ± 300   | 1700 ± 400       |
| J21148+0607  | 118 ± 11   | 0.53 ± 0.11 | 3800 ± 700   | 4050 ± 1000      |

### TABLE 4

**Civλ1549**

| IAU name   | v_r [km s^{-1}] | W(Civ) [Å] | FWHM(Civ) [km s^{-1}] | v_r, T [km s^{-1}] | W(Civ) [Å] | FWHM(Civ) [km s^{-1}] | Baln.I. [km s^{-1}] |
|------------|-----------------|------------|------------------------|-------------------|------------|------------------------|---------------------|
|            | (1)             | (2)        | (3)                    | (4)               | (5)        | (6)                    | (7)                 |
| J00457+0410| -1800           | 10         | 8000                   | -11300            | -16000     | -11                   | 7300                |
| J08045+6459| -5000           | 33:        | 6000:                  | -13400            | -27000     | -40                   | 9000                |
| J10043+0513| -1300           | 52         | 3800                   | -8700             | -12000     | -5                    | 3000                |
| J10074+1248| -3000           | 3^{+2}_{-2} | 6000:                 | -6700             | -12000     | -12                   | 5950                |
| J11292-0424| +900^{+200}_{-1000} | 42:   | 2200:                  | -2400             | -5000      | -4.6                  | 1500                |
| J12562+5652| +0^{+500}_{-1000}  | 16         | 5900                   | -8300             | -10000     | -5                    | 3400                |
| J13532+6345| +0              | 31:        | 2400                   | -1200             | -3500      | -5.5                  | 1800                |
| J14138+4400| +300^{+200}_{-1000} | 36:   | 2200:                  | -1450             | -4000      | -7^{+2}_{-7}          | 1000^{+2000}_{-500} |
| J15366+5433| +1000          | 18         | 1500                   | -800              | -2500      | -4                    | 1500                |
| J15547+0822| -1000^{+500}_{-500} | 60     | 3700                   | -11000            | -17000     | -6^{+2}_{-6}          | 5000:               |
| J17014+5149| -3100           | 19^{+10}_{-10} | 7000:                 | -15000            | -27000     | -73                   | 14200               |
| J21148+0607| -550            | 23         | 4600                   | -15600            | -26000     | -22                   | 9700                |

A double colon mark indicates highly uncertain values.
## Table 5

**HIGH Z BAL OR MINI-BAL QSOS WITH CIVλ1549 SHIFT**

| Object                  | z       | FWHM(Hβ) | FeII<sub>opt</sub> | [OIII] | Δν<sub>r</sub> (CIVλ1549) |
|-------------------------|---------|----------|-------------------|--------|--------------------------|
| (1)                     | (2)     | (3)      | (4)               | (5)    | (6)                       |
| 0043+008 (UM275)        | 2.146<sup>b</sup> | 4300:   | weak              | 0<sup>c</sup> | 0<sup>c</sup>           |
|                         | 2.1526<sup>d</sup> |         |                   | -500<sup>c</sup> |             |
| 0226-038 (RL?)          | 2.073<sup>b</sup> | 2800:   | weak              | -900<sup>c</sup> |             |
| 0842+345 (CSO203)       | 2.163<sup>b</sup> | 8400:   | strong            | -3000<sup>c</sup> |             |
| 1011+091                | 2.305<sup>b</sup> | 7500:   | strong            | -4000<sup>c</sup> |             |
| 1246-057                | 2.244<sup>f</sup> | 4500<sup>g</sup> | strong          | -2000<sup>c</sup> |             |
|                         | 2.243<sup>b</sup> | 5900:   | strong            | -2000<sup>c</sup> |             |
|                         | 2.246<sup>h</sup> |         |                   | -2200<sup>c</sup> |             |
| 1309-056                | 2.220<sup>b</sup> | 3200:   | strong            | -750<sup>c</sup> |             |
|                         | 2.239<sup>b</sup> |         |                   | -2500<sup>c</sup> |             |
| H1413+117               | 2.551<sup>f</sup> | 4000<sup>g</sup> | strong          | 0<sup>j</sup> | -600<sup>i</sup> |
|                         | 2.558<sup>i</sup> |         |                   |         |             |
| LBQS2212-1759           | 2.228<sup>b</sup> | 6100:   | weak              | -600<sup>c</sup> |             |

<sup>a</sup> Sources for which a reliable measurements of systemic z and CIVλ1549 emission component shift exist.

<sup>b</sup> From [OIII]λ4959,5007 as reported in McIntosh et al. (1999).

<sup>c</sup> Korista et al. (1993) UV/CIVλ1549 redshifts.

<sup>d</sup> From SDSS.

<sup>e</sup> From SDSS.

<sup>f</sup> UV z from Lanzetta et al. (1987)

<sup>g</sup> Hill et al. (1993).

<sup>h</sup> Hill et al. (1993) – Hα.

<sup>i</sup> Espey et al. (1989) – Hα.

<sup>j</sup> Barvains et al. (1997) from CO.

<sup>k</sup> CIVλ1549 emission; Angonin et al. (1990).
Fig. 1. Deredshifted spectra for low redshift BAL QSOs: C iv λ1549 (left) and Hβ spectral regions (right). Solid line is the spectrum converted to rest frame specific flux (erg s$^{-1}$ cm$^{-2}$ Å$^{-1}$). Green dotted line indicated Fe II$_{UV}$ and Fe II$_{opt}$ emission. Dot-dashed lines show the continuum level.
Fig. 2. Continuum and Fe II subtracted profiles of CIVλ1549 and H\textbeta for 8 BAL QSOs in our sample. Ordinate is rest frame specific flux ($10^{-15}$ ergs s$^{-1}$ cm$^{-2}$ Å$^{-1}$) and abscissa is radial velocity (km s$^{-1}$) with respect to rest frame. The upper and lower halves of each panel show CIVλ1549 and H\textbeta profiles respectively. A high order spline fit (thick line) superimposed on the H\textbeta line indicates the broad component. Dotted lines mark the quasar rest frame for CIVλ1549 and H\textbeta, as well as the expected position of [OIII]λ4959,5007. The side of the absorption/emission profiles below and above $v_r \approx 0$ km s$^{-1}$ are colored blue and red respectively.
Fig. 3. Continuum and Fe\textsubscript{II} subtracted profiles of C\textsc{iv}λ1549 and H\textbeta for n=4 mini-BAL QSOs in our sample following Fig. 2. Dashed line (colored green) shows the assumed unabsorbed profile used for absorption component measurements. In the case of Mrk 486 (≡ J15366+5433), the thick green line shows the HST C\textsc{iv}λ1549 profile with no absorption.
Fig. 4. The optical parameter plane of Eigenvector 1 with our sample BAL and mini-BAL quasars indicated by large and small dots, respectively. Small and large dashed horizontal lines indicate upper limits for NLSy1 and Pop. A sources. The green continuous line traces the expected location as a function Eddington ratio and orientation, following Marziani et al. (2001). The grid represents the principal zone of low $z$ source occupation as modelled for an $M_{\text{BH}} = 10^8 M_\odot$. The large, circular dots set the scale of the grid indicating the expected position for $i = 40^\circ$ and $\log L_{\text{bol}}/M_{\text{BH}} \approx 3.3$ (in solar units; upper right) and for $i = 10^\circ$ and $\log L_{\text{bol}}/M_{\text{BH}} \approx 4.5$ (lower left). Lines tracing the orientation effect between minimum and maximum $i$ are incremented by $\Delta \log L_{\text{bol}}/M_{\text{BH}} = 0.1$. Arrows on outlier sources (Mrk 231 and IRAS 07598+6508) indicate direction of displacement after correction for a wind-related $H_\beta$ component not seen in most other low $z$ quasars. The square identifies PG 1001+054 which has a highly uncertain absorption trough.
Fig. 5. Outlier sources IRAS 07598+6508 (≡ J08045+5459, left) and Mrk 231 (≡ J12562+5652, right) HβBC with Lorentzian profile model of unshifted component most similar to majority of sources (thick green line) using same width FeⅡopt lines (≈ 2100 km s\(^{-1}\); thin green lines). Original continuum subtracted spectra shown as thin solid lines. Thick solid lines show “cleaned” HβBC (after FeⅡopt subtraction). Lower panel: Residual components after subtraction of the Lorentzian profile from HβBC. Dashed line marks the radial velocity at which CIVλ1549 absorption begins. Abscissa is radial velocity difference from rest frame (km s\(^{-1}\)); ordinate is rest frame specific flux.

Fig. 6. Correlation between absolute V magnitude \(M_V\) and wind terminal velocity (in km s\(^{-1}\)). Symbols used for data points have the same meaning of Fig. 4. The solid line is an unweighted least-square fit made including all 12 data points. The dotted lines trace the ± 95% confidence intervals. The dashed line is the fit shown in Fig. 6 of [Laor & Brandt 2002], converted to the cosmology adopted in this paper.
Fig. 7. Cartoon depicting the basic structure needed to account for the BAL profiles discussed in §5.1. The observer looking at the edge of a cone of opening angle $\approx 100^\circ$, sees a fully blueshifted emission component, a BAL and a second, narrower BAL originating in an axial sheet of gas participating in the general BLR outflow. See text for details.