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# On the nature of $z_{\rm abs} \approx z_{\rm em}$ damped absorbers in quasar spectra*

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**Abstract.** We present spectroscopic observations of the damped Ly$\alpha$ absorber at redshift $z$ = 1.9342 seen in the spectrum of the quasar Q0151+048A. The redshift of the absorber is greater than the redshift of the quasar, so the system resembles the $z_{\rm abs} \approx z_{\rm em}$ damped absorber at $z$ = 2.81 towards the quasar PKS0528-250. We have previously reported the detection of Ly$\alpha$ emission from the latter absorber, one of only two damped absorbers for which Ly$\alpha$ emission has unambiguously been detected. The resemblance between the PKS0528-250 and Q0151+048A systems is made closer by the detection of a weak emission feature in the trough of the Q0151+048A absorber. This leads us to consider whether these $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are different objects to the intervening DLA absorbers. Two possibilities are examined and rejected. Firstly the Q0151+048A and PKS0528-250 $z_{\rm abs} \approx z_{\rm em}$ absorbers appear to be unrelated to the intrinsic absorbers (i.e. gas close to the quasar nucleus, ejected by the quasar), as intrinsic absorbers are of higher metallicity, have higher ionisation parameter, and show complex absorption profiles. Secondly these two DLA absorbers cannot be equated with the gaseous disks of the quasar host galaxies, as the absorber redshifts differ significantly from the quasar systemic redshifts. It is likely, then, that intrinsically the $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are the same as the intervening DLA absorbers, so that peculiarities in some of the $z_{\rm abs} \approx z_{\rm em}$ absorbers can be ascribed to their different environment i.e. proximity to the quasar, or membership of the same cluster as the quasar. We point out that the proximity effect may play some rôle, by reducing the Ly$\alpha$-forest line blanketing of any Ly$\alpha$ emission line from $z_{\rm abs} \approx z_{\rm em}$ absorbers.

**Key words:** galaxies: abundances – intergalactic medium – quasars: absorption lines – quasars: individual: Q0151+048A

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* Based on observations collected at the European Southern Observatory, La Silla, Chile.

## 1. Introduction

Two optical strategies have been employed to search for high–redshift normal galaxies. Using narrow–band imaging to detect Ly$\alpha$, relatively few have been discovered (e.g. Lowenthal et al. 1991, Møller & Warren 1993 (hereafter Paper I), Francis et al., 1996). However, recently Steidel and collaborators have had considerable success with broad-band imaging, identifying candidates by the expected Lyman break in their spectra (Steidel et al., 1996). The same strategy applied to the Hubble Deep Field data has provided a measurement of the global star formation rate in galaxies in the redshift interval $2 < z < 4$ (Madau et al 1997).

The searches for starlight from high–redshift galaxies are complemented by the analysis of the damped Ly$\alpha$ (DLA) absorption lines in the spectra of high–redshift quasars. The DLA studies have yielded measurements of the mass density of neutral hydrogen in the universe (e.g. Wolfe, 1987; Lanzetta et al., 1991), and the abundance of heavy elements in the gas (e.g. Pettini et al., 1994; Lu et al., 1996), and how these quantities have changed with redshift. The relation between the DLA absorbers and the Lyman-break galaxies is not yet well established, but is important, as it will connect the measured global rate of star formation with the evolution of the global density of neutral gas, and its chemical enrichment. This will allow a more detailed comparison with theories of how galaxies are assembled. For this reason considerable effort has been devoted to the detection of DLA absorbers in emission, in order to measure the star formation rate for the absorber, and the sizes of the cloud of neutral gas, and of the region of star formation.

Unfortunately to date only two DLA absorbers have been successfully, and unambiguously, identified. These are i.) the system at $z$ = 2.81, of column density log($N_{\rm HI}$) = 21.35, seen in the spectrum of the quasar PKS0528-250 (Paper I), and ii.) the system at $z$ = 3.15, of column density log($N_{\rm HI}$) = 20.00, seen in the spectrum of the quasar Q2233+131 (Djorgovski et al 1996). In the latter case the column density is below the value usually recognised as defining a DLA system, but we will treat it as a DLA absorber here. The PKS0528-250 $z$ = 2.81

DLA absorber has been the subject of extensive imaging and spectroscopic observations by ourselves. These have yielded clues to the connection between DLA absorbers and the Lyman break galaxies, described below. The absorber is nevertheless unusual as the redshift is similar to the redshift of the quasar. There are only a few such $z_{abs} \approx z_{em}$ DLA absorbers known.[1]

The detection of Ly$\alpha$ emission from the PKS0528-250 $z$ = 2.81 DLA absorber, as well as from two companions with similar redshifts, was reported in Paper I. The DLA absorber (as well as the companions) has subsequently been detected in the continuum, with the Hubble Space Telescope (HST), confirming that the Ly$\alpha$ emission is due to star formation rather than photoionisation by the quasar (Møller & Warren, 1996). The measured half light radius of the continuum emission, $r_{0.5}$ = 0.13″, and the apparent magnitude, $m_B$ = 25.5, are within the range measured for Lyman-break galaxies, which led us to suggest that the two are essentially the same population (Møller & Warren, 1997, hereafter Paper III). The two companions in this field are similarly small in size. These HST observations support our earlier suggestion (Warren & Møller, 1996, hereafter Paper II), based on dynamical evidence, that these three objects are subunits of a galaxy in the process of assembly.

Pettini et al (1995) have detected a similar slightly-offset emission line in the trough of a second $z_{abs} \approx z_{em}$ damped absorber at $z$ = 3.083, towards the quasar 2059-360. Ly$\alpha$ emission may therefore be more common in or near DLA absorbers near quasars than in or near intervening DLA absorbers. Because of the unusual nature of the PKS0528-250 absorber, and to investigate the possibility that Ly$\alpha$ emission in DLA absorbers is in some way enhanced in $z_{abs} \approx z_{em}$ systems, over intervening systems, we have obtained spectra of a third $z_{abs} \approx z_{em}$ DLA absorber, the system at $z$ = 1.93 seen in the spectrum of the quasar Q0151+048A. This absorber was first studied by Williams & Weymann (1976). The quasar (=UM144=PHL1222, 1950.0 coordinates RA 1 51 17.43, Dec 4 48 15.1) is radio quiet, optically is relatively bright ($m_V$ = 17.63, $m_B$ = 18.03), non variable, and has a faint ($m_V$ = 21.2) companion quasar Q0151+048B lying 3.3″to the NE, and at a similar redshift, discovered by Meylan et al. (1990).

The spectroscopic observations are described in §2. In §3 we present the spectrum. By fitting a Voigt profile to the damped absorption line we find evidence for an emission line near the base of the trough, just blueward of the absorption line centre. In §4 we provide a discussion of the question of whether the $z_{abs} \approx z_{em}$ DLA absorbers are intrinsically different to the intervening DLA absorbers, and in §5 we list our conclusions.

## 2. Observations and data reduction

On the nights of 1994 August 3 and 4 we obtained two spectra of Q0151+048A, of combined integration time 6200 seconds, using the blue arm of the EMMI instrument on the ESO 3.5m NTT. We used grism # 3 (1200 grooves mm$^{-1}$, blazed at 3800Å) and a 1.5″ slit, yielding a resolution of 2.0Å. The detector was a Tektronix 1024 × 1024 CCD, binned by a factor two in the dispersion direction, giving a pixel size of 0.38″ × 0.90Å. The readout noise of the chip was $8e^{-}$. The journal of observations is provided in Table 1.

[1] In this paper we refer to absorbers with redshifts within a few thousand km s$^{-1}$ of the quasar emission redshift as $z_{abs} \approx z_{em}$ absorbers, and to absorbers at lower redshift as intervening absorbers.

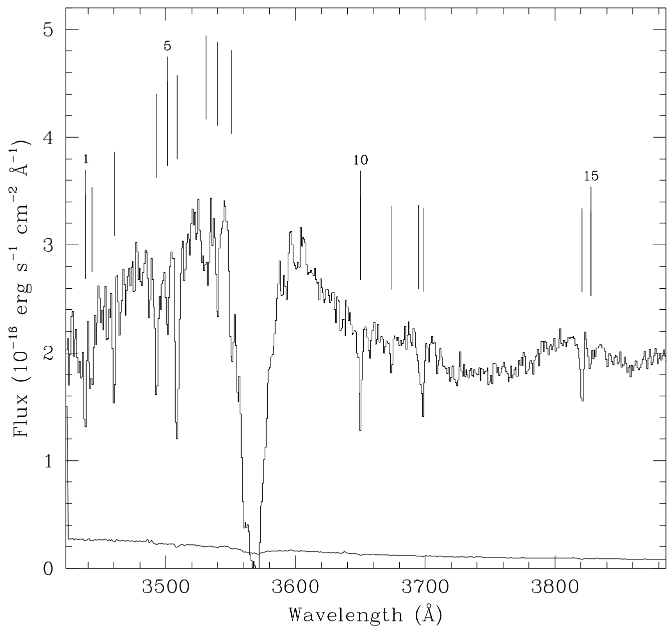


**Fig. 1.** Combined spectrum of Q0151+048A in the region of the DLA absorption line. Flux per unit wavelength is plotted against wavelength. The lower solid line shows the 1$\sigma$ noise spectrum. The spectrum has not been corrected for relative slit losses which were substantial (see text §3.2).

**Table 1.** Journal of observations

| Date | Target | Exp. (sec) | Seeing (″) | PA (E of N) |
|---|---|---|---|---|
| 3 Aug 94 | Q0151+048A | 2600 | 2.2 | 90° |
| 4 Aug 94 | Q0151+048A | 3600 | 3.8 | 120° |

The spectra were reduced using standard techniques for bias and dark subtraction, and flatfielding. One dimensional spectra were extracted and combined using the optimising extraction routine described by Møller & Kjærgaard (1992). The final spectrum is shown in Fig. 1.

## 3. Results

### *3.1. Absorption lines in the spectrum of Q0151+048A*

The line search algorithm described in Møller et al. (1994) was used to find, measure, and identify absorption lines. In this case the continuum against which absorption lines were measured included the absorption of a damped Voigt profile near 3567Å, with parameters as described below. The resulting line list, ex-

**Table 2.** Absorption lines in Q0151+048A

| No. | $\lambda_{obs}$ (Å) | $W_{obs}$ (Å) | $\sigma_W$ (Å) | ID | $z_{abs}$ |
|---|---|---|---|---|---|
| 1 | 3438.4 | 0.94 | .18 | | |
| 2 | 3443.1 | 0.98 | .23 | | |
| 3 | 3460.6 | 0.97 | .15 | | |
| 4 | 3493.0 | 1.24 | .14 | SiII (1190) | 1.9343 |
| 5 | 3501.3 | 1.02 | .18 | SiII (1193) | 1.9342 |
| 6 | 3509.0 | 2.24 | .17 | | |
| 7 | 3530.9 | 1.07 | .17 | | |
| 8 | 3539.8 | 0.84 | .12 | | |
| 9 | 3550.7 | 1.13 | .13 | | |
| 10 | 3649.8 | 1.15 | .13 | SiIV (1393) | 1.6187 |
| 11 | 3673.9 | 0.34 | .09 | SiIV (1402) | 1.6190 |
| 12 | 3695.1 | 0.57 | .11 | | |
| 13 | 3698.3 | 0.80 | .09 | SiII (1260) | 1.9342 |
| 14 | 3820.8 | 0.76 | .07 | OI (1302) | 1.9342 |
| 15 | 3827.4 | 0.52 | .12 | SiII (1304) | 1.9343 |

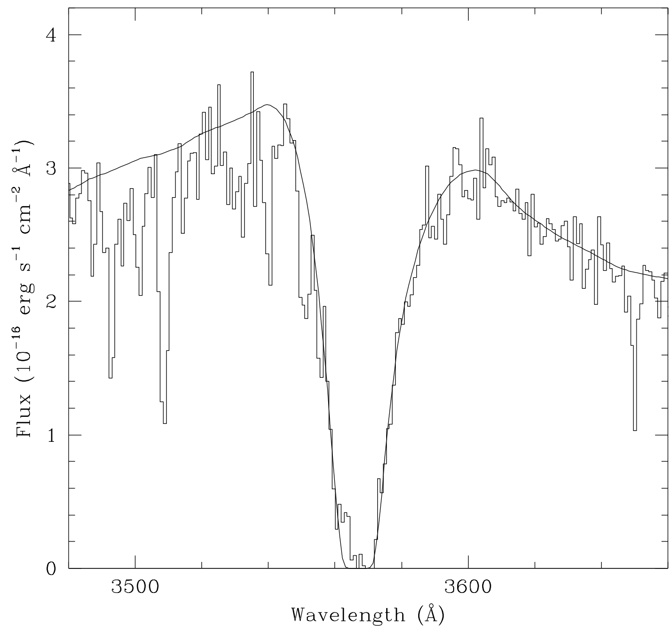


**Fig. 2.** Observed spectrum of Q0151+048A. The smooth line shows the fit to the damped absorption line, for values of N(HI) = $2.3\times10^{20}$cm$^{-2}$, $z_{abs}$ = 1.9342. Note the residual in the blue side of the saturated part of the DLA line.

cluding the DLA line, and complete to $4\sigma$, is provided in Table 2. Listed there are the observed vacuum wavelength, the observed equivalent width $W_{obs}$, and the $1\sigma$ error on the equivalent width $\sigma_W$, for each line. The error on the wavelengths of the line centroids is dominated by the uncertainty associated with centring the quasar in the slit, and is estimated to be 0.4Å.

Sargent et al. (1988) have identified lines 14 and 15 as the CIV(1548, 1550) doublet at $z$ = 1.468. With our identification the wavelength difference between the OI(1302) and SiII(1304) lines, at $z$ = 1.9342, is 6.46Å, whereas with their identification the wavelength difference is only 0.11Å less. With these data it is not possible to distinguish between these two possibilities, but given the strength of the other SiII lines at $z$ = 1.9342 we find the most natural identification is that given in Table 2.

The DLA line near 3567Å absorbs part of the quasar Ly$\alpha$ and NV emission lines, so to determine the best-fit parameters for the damped line it was necessary to allow for the fact that the unabsorbed spectrum (the "continuum") is not at all flat in the region of the DLA line. By dividing the spectrum by the Voigt profile for trial values of redshift and column density, a first solution for these parameters was found, which produced a realistic unabsorbed quasar emission line profile – disregarding the wavelength region over which the absorption line is saturated. A smooth continuum, including Ly$\alpha$ and NV emission lines, was fitted to this corrected spectrum, interpolating across the saturated region, 3560Å − 3573Å. For this continuum we now determined the Voigt profile which best fit the observed spectrum. Dividing again by the model, the procedure was iterated to a solution. The results of this process are illustrated in Fig. 2, which shows an expanded plot of the spectrum in the region of the damped line, together with the best fit to the absorption line.

While there is a certain amount of arbitrariness in the details of the final model for the quasar emission lines, the same is not true for the DLA absorption line. The parameters of this line are strongly constrained by the saturated central part and by the steep sides. The best fit was obtained with N(HI) = $2.3\times10^{20}$cm$^{-2}$, $z_{abs}$ = 1.9342, but acceptable fits could be obtained for column densities in the range $2-4\times10^{20}$cm$^{-2}$.

### *3.2. Emission from the DLA absorber*

Inspection of Fig. 2 shows that the model provides a close match to the profile of the absorption trough, except in the bottom of the DLA line where there appears to be a weak narrow emission line at the blue edge of the saturated part of the profile. On the assumption that the model absorption profile is correct, as evinced by the excellent fit at all other wavelengths, this emission feature is significant at the $4.5\sigma$ level. Note that while it is possible to obtain other acceptable fits to the absorption trough by adjusting slightly the modelled Ly$\alpha$ and NV quasar emission lines, and making corresponding changes to the DLA parameters, this can never significantly change the saturated part of the absorption line profile, so the flux in this emission feature is quite insensitive to the details of the fitting. To illustrate the emission feature more clearly we have subtracted the model absorption profile from the data, and divided the difference by the $1\sigma$ error spectrum. The resulting residuals (smoothed for display purposes) are shown in Fig. 3.

The wavelength centroid of the emission line is 3563.4 Å, and the measured line flux is $1.2\pm0.3\times10^{-16}$ergs cm$^{-2}$ s$^{-1}$. However the spectrum of Fig. 1 has not been corrected for relative slit losses between the quasar and the spectrophotometric standard. These were substantial because the quasar was observed at large zenith distance. Therefore we calibrated our spectrum by firstly scaling to the spectrum of Osmer,

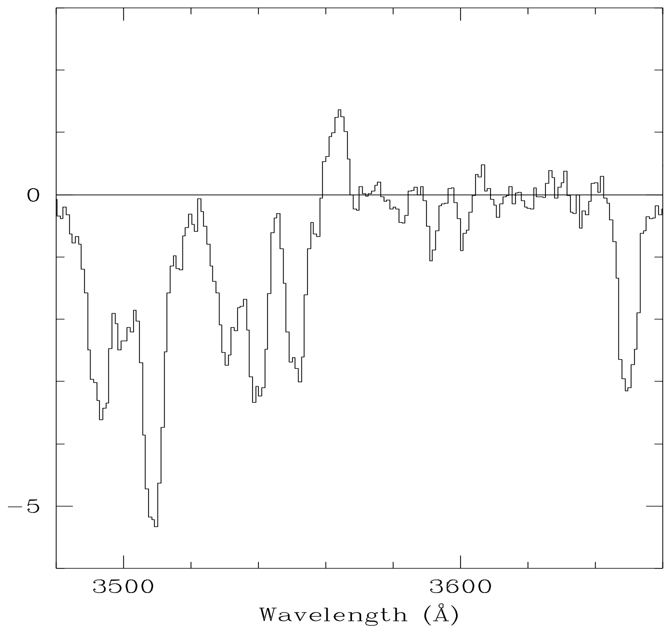


**Fig. 3.** Illustration of the emission feature at 3563.4 Å. After subtraction of the model absorption profile, the residuals of the quasar spectrum were divided by the $1\sigma$ error spectrum. Plotted is the resultant signal-to-noise spectrum, smoothed with a 5-pixel boxcar filter. The emission feature, if Ly$\alpha$, is blueshifted relative to the DLA line by $\approx$ 300km s$^{-1}$.

Porter, and Green (1994), and then scaling their spectrum to the literature UBV magnitudes. This brings the line flux to $\approx 3.5 \times 10^{-16}$ergs cm$^{-2}$ s$^{-1}$, and indicates that we only captured about 35% of the flux. The new value for the line flux may still be an underestimate of the total line flux, dependent on the angular size of the emission-line region relative to the slit width. If the line is interpreted as Ly$\alpha$ emission the redshift of the object is $z_{em}$ = 1.9312, which is 300km s$^{-1}$ to the blue of the absorber. The line luminosity would be several times that for the DLA absorber towards PKS0528-250 (object S1, Paper I).

### *3.3. The emission redshifts of Q0151+048A, B*

In considering the nature of the DLA absorber, and the object responsible for the emission line, it is important to measure accurately the redshift of the quasar. The Balmer lines or narrow forbidden lines can be used to measure the systemic redshift, but have yet to be observed for this object. Instead we must use lines in the restframe UV. However it is well documented that the high ionization lines (e.g. CIV here) are blueshifted relative to the quasar systemic redshift by typically several hundred km s$^{-1}$ (e.g. Espey 1989, Tytler & Fan 1992, Espey 1997). Any blueshift for the low ionisation lines (e.g. SiII, OI, MgII here) fortunately is small.

In Table 3 we collect values of the redshift measured for a number of lines in the spectrum of the quasar Q0151+048A, as well as the MgII line in the spectrum of the quasar Q0151+048B. All estimates are from fits to the line peak. The values for the weak SiII and OI lines are our own measurements from the spectrum of Fig. 2. For both of these lines we used rest wavelengths of both multiplets under the assumption that the lines are optically thick. The values for the Ly$\alpha$ and NV lines are also our own measurements from the spectrum of Fig. 2, but here after division by the model DLA line. This correction does not strongly add to the uncertainty of the NV emission redshift, but the error on the Ly$\alpha$ emission redshift is dominated by the uncertainty due to the absorption correction. The data for the SiIV and CIV lines are taken from Sargent et al (1988). The SiIV redshift is not very useful however, as the line is chopped up by strong absorption lines, and it is only included in the table for the sake of completeness. The values for the MgII lines for the two quasars were measured by us from the plots of the spectra provided by Meylan et al (1990).

In a large study Tytler & Fan (1992) found that, after accounting for measurement errors, the intrinsic scatter of the blueshift of any particular line relative to the systemic redshift is small, no more than 200km s$^{-1}$, and they tabulated mean values of the blueshift for several lines. The corrections are smallest for the low ionisation lines. For example for OI and MgII they found mean values of 50 and 100 km s$^{-1}$ respectively. In the last column of Table 3 we list the redshifts (TF) after applying the corrections suggested by Tytler & Fan.

As discussed below, the corrections for the high-ionisation lines may not be suitable for bright quasars. Therefore to estimate the quasar systemic redshift we have formed a weighted mean of the redshifts for the three lines SiII, OI, MgII, and added 100 km s$^{-1}$ to the final error as an estimate of the systematic uncertainty. Our best estimate of the systemic redshift for Q0151+048A is then $z$ = 1.922 $\pm$ 0.003. For Q0151+048B our best estimate for the redshift is based on the MgII line only, and is $z$ = 1.937 $\pm$ 0.005.

From Table 3 it can be seen that for the two high ionization lines, CIV and NV, the corrections suggested by Tytler & Fan are too small. The CIV line in Q0151+048A is blueshifted by 1440km s$^{-1}$ relative to the systemic redshift, and this is much larger than the mean blueshift for this line of 310km s$^{-1}$ quoted by Tytler & Fan. Espey (1997), and Møller (1997) have found several other cases of quasars where the CIV line is blueshifted by a similar, or larger, amount. Both Corbin (1990) and Espey (1997) find a correlation between blueshift of the CIV line and quasar brightness, and this is likely to be the explanation for the discrepancy, since the sample of Tytler & Fan contains very few optically bright quasars. In fact the correlation is visible in their Fig. 27. The correlation found by Espey would suggest a correction of $\approx$ 1100km s$^{-1}$ for the CIV line for Q0151+048A, bringing it in line with the low ionisation lines.

To summarise, our best estimate for the systemic redshift of Q0151+048A is 1.922 $\pm$ 0.003, which is 1250 $\pm$ 300km s$^{-1}$ lower than the redshift of the DLA absorber.

**Table 3.** Emission lines and derived emission-line redshifts

| Object | Ion | $\lambda_{\rm vac}$ (Å) | $z_{\rm em}$ (peak) | $W_{\rm obs}$ (Å) | $W_{\rm rest}$ (Å) | $z_{\rm em}$ TF |
|---|---|---|---|---|---|---|
| Q0151+048A: | Ly$\alpha$ [a] | 1215.67 | [1.917] | 140 | 48 | |
| | NV[a] | 1240.13 | 1.904 | 12.3 | 4.2 | 1.906 |
| | SiII | 1264.7 | 1.921 | 6.1 | 2.1 | 1.922 |
| | OI | 1304.46 | 1.924 | 11.9 | 4.1 | 1.924 |
| | SiIV+OIV][b] | 1399.7 | [1.898] | 41 | 14 | |
| | CIV[b] | 1549.1 | 1.908 | 64 | 22 | 1.911 |
| | MgII[c] | 2798.74 | 1.921 | | | 1.922 |
| Q0151+048B: | MgII[c] | 2798.74 | 1.936 | | | 1.937 |

[a] Measured after correction for DLA absorption
[b] From Sargent et al. 1988
[c] Measured on spectrum in Meylan et al. 1990

## 4. Discussion

The redshift of the DLA absorber towards Q0151+048A is larger than the redshift of the quasar, so the system resembles the $z_{\rm abs} \approx z_{\rm em}$ damped absorber at $z = 2.81$ towards the quasar PKS0528-250, for which we have previously reported the detection of Ly$\alpha$ emission (§1). The detection of emission in the trough of the Q0151+048A absorber therefore makes the resemblance closer. The line could be Ly$\alpha$ emission from the absorber or from a companion. We defer a detailed discussion of the nature of the emitter to a subsequent paper, where we will report on narrow-band imaging observations of the line (Fynbo, Møller, & Warren, in preparation). However it is interesting to note that Pettini et al. (1995) have discovered a similar, slightly offset, emission line in the trough of a third $z_{\rm abs} \approx z_{\rm em}$ damped absorber, towards the quasar 2059-360. It appears, therefore, that Ly$\alpha$ emission may be more common in or near DLA absorbers near quasars than in or near intervening DLA absorbers. Therefore in this section we firstly consider whether these $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are representatives of a different population to the intervening DLA absorbers. Two possibilities are considered; that the clouds belong to the class of intrinsic absorbers, probably ejected by the quasar, or that we are seeing the disks of the host galaxies. Both possibilities are rejected, so it is probable that the $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are similar to intervening DLA absorbers. This leads us to consider briefly the likely reason for enhanced Ly$\alpha$ emission near quasars.

In the following we limit ourselves to a discussion of the Q0151+048A and PKS0528-250 systems, as the relevant information for the quasar 2059-360 has yet to be published.

### *4.1. The nature of $z_{\rm abs} \approx z_{\rm em}$ DLA systems*

#### 4.1.1. Intrinsic $z_{\rm abs} \approx z_{\rm em}$ systems

If the $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are different from the intervening systems, one possibility is that they belong to the class of intrinsic absorbers, which includes the broad absorption lines (BALs), and the narrow intrinsic $z_{\rm abs} \approx z_{\rm em}$ systems optically thin in the continuum (Savaglio et al. , 1994; Møller et al. , 1994; Hamann 1997), which are possibly related to BAL systems. Both types of intrinsic absorber typically display complex, but generally smooth absorption profiles (e.g. Barlow & Sargent, 1997), whereas both the damped systems under discussion are well fit by single-component Voigt profiles. Intrinsic $z_{\rm abs} \approx z_{\rm em}$ systems also typically have very high metal abundances, solar or several tens times solar (Petitjean et al. , 1994; Møller et al. , 1994; Hamann 1997). The metallicity of the DLA absorber in PKS0528-250, on the other hand, was measured by Meyer et al. (1989) to be only 12% solar, and by Lu et al. (1996) to be 17% solar. These values are representative of other DLA absorbers. The metallicity of the Q0151+048A DLA absorber has yet to be measured.

The intrinsic $z_{\rm abs} \approx z_{\rm em}$ systems are also typically characterised by high ionization parameter. If one were to increase the column density of such a system to the point where it became optically thick to Lyman continuum photons, low ionization absorption lines would become visible. However, the part of the cloud facing the quasar would remain highly ionized, and one would have a system with mixed ionization (strong CIV and NV as well as SiII and CII). However neither of the DLA systems under discussion show strong NV absorption. Therefore, on the basis of absorption profile, metallicity, and ionisation parameter these two absorbers appear to be representative of other DLA absorbers, rather than the intrinsic $z_{\rm abs} \approx z_{\rm em}$ systems.

#### 4.1.2. Quasar host galaxies

Another possible explanation might be that we are seeing neutral gas in the quasar host galaxy disk. However for Q0151+048A the quasar systemic redshift 1.922 ± 0.003 (§3) and the absorber redshift $z = 1.9342 \pm 0.0003$ are significantly different. The same is probably true of PKS0528-250. Here the absorber redshift is $2.8115 \pm 0.0007$, which differs from the quasar emission redshift $2.768 \pm 0.002$, measured by us from the CIV line, by 3440km s$^{-1}$. As discussed in §3 the systemic redshift of the quasar will be higher than the value measured from the CIV line. However, if we follow Tytler & Fan (1992) the correction is only 310km s$^{-1}$, whereas Espey's (1997) work would suggest a correction of no more than $\approx$ 1500km s$^{-1}$. Therefore these two DLA absorbers do not appear to be the signatures of disks of the quasar host galaxies.

### *4.2. Ly$\alpha$ emission and the effect of the quasar*

If, as strongly suggested by the above discussion, the $z_{\rm abs} \approx z_{\rm em}$ DLA systems are the same as intervening DLA systems, the enhanced Ly$\alpha$ emission in or near the $z_{\rm abs} \approx z_{\rm em}$ absorbers implies that they occupy different environments to the intervening systems. The most obvious explanation that comes to mind is that the emission lines in the troughs of the Q0151+048A and 2059-360 absorbers, if Ly$\alpha$ , are due to photoionisation by the quasar. However, one can imagine several other possible explanations for the enhanced emission. For example gravitational interaction between the quasar and absorber might induce star formation. In any case the Ly$\alpha$ emission from the PKS0528-250 DLA appears to be due to star formation, as we have detected continuum emission from the absorber, as well as from two Ly$\alpha$ emitting companions (Paper III). This might suggest, instead, that the explanation for enhanced Ly$\alpha$ emission near quasars is that quasar activity (whatever the cause) is more common in regions where young galaxies are actively forming stars.

Another factor which could play a rôle is the so called proximity effect (e.g. Bajtlik et al. , 1988). Powerful quasars are able to ionize the neutral hydrogen in the Lyman forest out to large distances from the quasar. The effect of this would be to reduce any line blanketing of Ly$\alpha$ emission from galaxies in the vicinity of the quasar. Although the average line blanketing in the Ly$\alpha$ forest of the continuum of a quasar is only modest at this redshift, $\sim$ 0.3, the average line blanketing of the Ly$\alpha$ emission line of a galaxy might be greater as it would be enhanced by the cloud-galaxy correlation function.

## 5. Summary and conclusions

1. In this paper we have presented spectra of the quasar Q0151+048A, and found evidence for emission in the trough of the $z_{\rm abs} \approx z_{\rm em}$ DLA absorption line at $z$ = 1.9342.
2. We have previously reported the detection of Ly$\alpha$ emission from the $z$ = 2.81 $z_{\rm abs} \approx z_{\rm em}$ DLA system towards the quasar PKS0528 − 250, while an emission line in the trough of a third $z_{\rm abs} \approx z_{\rm em}$ DLA absorber, at $z$ = 3.083, has also recently been reported. There is only one published successful detection of Ly$\alpha$ emission from an intervening DLA absorber, so these results suggest that Ly$\alpha$ emission is more common in or near $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers than in or near intervening DLA absorbers.
3. Despite this we find no evidence that $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers are not members of the same population as intervening DLA absorbers. In particular we are unable to make a connection between the $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers and the so-called intrinsic absorbers, which are of higher metallicity and higher ionisation. Neither is it possible to associate the $z_{\rm abs} \approx z_{\rm em}$ DLA absorbers with the disk of the quasar host galaxy, as the redshifts of the absorbers are not compatible with the measured quasar systemic redshifts.
4. Star formation is almost certainly the cause of the Ly$\alpha$ emission from one of the three absorbers discussed here. Photoionisation by the quasar could be the explanation for the other two emission lines, but this can only be established by more detailed studies, and other explanations are possible.

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