1. INTRODUCTION

Over the past 25 years, spectroscopic QSO surveys have established the statistics of intervening metal line absorption systems, most notably those selected via C IV and Mg II resonance transitions (e.g., Weymann et al. 1979; Lanzetta et al. 1987; Tytler et al. 1987; Sargent et al. 1988; Steidel & Sargent 1992; Churchill et al. 1999, hereafter CRCV99; Nestor et al. 2005a, hereafter NTR05). These systems identify structures based on their gas absorption cross section and are widely believed to select galactic structures and extended gaseous galactic halos (e.g., Bergeron & Boissé 1991; Steidel et. al. 2002; Churchill et al. 2005). The results of the early Mg II surveys, which we summarize in NTR05, indicated that the distribution of rest equivalent widths of the 2796 line ($W_{\lambda 2796}$) can be described by a power law or an exponential and that the incidence of the strongest systems seems to be decreasing with decreasing redshift. In NTR05 we presented a large ($\approx$1300 systems) Mg II survey using the Sloan Digital Sky Survey (SDSS) Early Data Release (EDR) QSO spectra. We demonstrated that the $W_{\lambda 2796}$ distribution is fit very well by an exponential over the range $0.3 \lesssim W_{\lambda 2796} \lesssim 5$ Å and that previous power-law fits overpredict the incidence of strong lines. However, extrapolating the NTR05 exponential to weak (0.02 Å $\lesssim W_{\lambda 2796} < 0.3$ Å) systems underpredicts their incidence when compared to the results of CRCV99. This apparent transition is consistent with the idea that weak Mg II absorbers are in part comprised of a population that is physically distinct from intermediate/strong Mg II systems (e.g., Rigby et al. 2002). Since the transition occurs at the boundary of two different surveys, however, it is important to investigate the possibility that this is simply an artifact of some unknown systematic difference between the surveys.

NTR05 also investigated the incidence of Mg II systems as a function of redshift for different ranges of $W_{\lambda 2796}$. The results were consistent with the total proper cross section for absorption decreasing with decreasing redshift, especially at $z \approx 1$, such that the stronger lines evolve faster. The apparent evolution can be described by a steepening of the $W_{\lambda 2796}$ distribution with cosmic time. However, the data only reach $z \approx 0.37$, and the evolutionary signal has high significance only for very strong ($W_{\lambda 2796} \gtrsim 2$ Å) systems. Thus, extending the measurement of $dN/d\delta z$ to lower redshift is a major goal of this work. Furthermore, the evolution of Mg II systems over cosmic time has a more general significance, since Mg II absorbers trace neutral hydrogen. Extending the statistics of Mg II absorption to lower redshift is therefore important for the study of the evolution of the H i content of the universe as well. In fact, results from this survey have already been used to study the incidence of damped Lyα (DLA) systems at low redshift (Rao et al. 2006). Accurate measurements of the incidence of Mg II absorption systems as a function of $W_{\lambda 2796}$ and redshift for weak to “ultrashort” (4 Å $\lesssim W_{\lambda 2796} \lesssim 6$ Å) systems and from high to low redshift, together with kinematic and relative abundance information from high-resolution spectroscopy (see, e.g., Ding et al. 2005 and references therein) and composite spectrum analysis (e.g., Nestor et al. 2003), are making it possible to understand the physical nature and evolution of the structures selected by such systems. Here we present the results of a spectroscopic QSO survey conducted at the 6.5 m MMT on Mount Hopkins, Arizona. The goals of the survey are (1) to provide a survey large enough to detect a significant number of intermediate/strong systems (0.3 Å $\lesssim W_{\lambda 2796} \lesssim 2$ Å) and sensitive enough to measure weak (0.1 Å $\lesssim W_{\lambda 2796} < 0.3$ Å) systems in a single survey and (2) to extend the measurement of their incidence to lower redshift ($z \approx 0.15$). In § 2 we describe the observations and our data reduction procedure. We present the results in § 3. In § 4, we discuss the relevance of our results to the problem of understanding the nature of low-ionization metal line absorbers, and we present our conclusions in § 5.
Hopkins, Arizona. Useful data were collected on 17 nights spread over seven observing runs. The MMT spectrograph was operated using the blue channel optical layout with the 800 groove mm\(^{-1}\) grating, which corresponds to 0.75 \(\text{Å} \text{ pixel}^{-1}\) and a resolution of approximately 2.2 \(\text{Å}\). Exposure times varied with the QSO magnitude and varying observing conditions but were typically 10–15 minutes per object. Approximately 900 spectra of nearly 400 QSOs were collected. Quartz lamp exposures were used to correct for pixel-to-pixel sensitivity variances, and comparison lamp exposures (usually He-Ne-Ar) were used to wavelength-calibrate the spectra. The wavelength coverage varied slightly for each observing run but typically spanned \(\approx 3190 \text{ Å}\) to either \(\approx 5170\) or \(\approx 5465 \text{ Å}\).

The resulting data set comprised a total of 381 useful QSO sight lines. Continua were fitted to the reduced QSO spectra and Mg \(\text{II}\) doublet candidates found, inspected, and measured in a manner similar to that described in NTR05. The same software were used, although with slight modifications to account for the differences in resolution and wavelength coverage between the SDSS and MMT data.

3. RESULTS

The final MMT survey Mg \(\text{II}\) absorber sample consists of a total of 140 doublets. They cover the redshift range of 0.1973 \(\leq z \leq 0.9265\) and have \(W_0^{2796}\) values ranging from 0.128 to 3.165 \(\text{Å}\).

Figure 1 shows the distribution of \(W_0^{2796}\). The redshift path coverage as a function of \(W_0^{2796}\) is also shown. The resulting \(\partial N/\partial W_0^{2796}\) is shown as the histogram in Figure 2. The solid line is a maximum likelihood fit to the data having \(W_0^{2796} \geq 0.3\) \(\text{Å}\) of the form \(\partial N/\partial W_0^{2796} = N^*/W^* \exp(-W_0/W^*)\) (see NTR05) with \(W^* = 0.509 \pm 0.047\) and \(N^* = 1.089 \pm 0.121\). The dashed line is the fit to the low-\(z\) data from the SDSS EDR survey, with a mean redshift \((z_{\text{abs}}) = 0.655\). The systems found in the MMT survey have \((z_{\text{abs}}) = 0.589\). The points represent data from CRCV99, with \((z_{\text{abs}}) = 0.9\). The distribution determined from the MMT data is consistent with both the SDSS EDR and the CRCV99 results. Although there are only 26 systems in the two lowest \(W_0^{2796}\) bins of the MMT survey, \(\partial N/\partial W_0^{2796}\) for \(W_0^{2796} < 0.3\) \(\text{Å}\) is in very good agreement with the CRCV99 results and significantly (1.4 \(\sigma\) and 2.4 \(\sigma\), respectively) above the extrapolation of the single-exponent fit to \(\partial N/\partial W_0^{2796}\) for \(W_0^{2796} \geq 0.3\) \(\text{Å}\). Although the CRCV99 data have a higher mean redshift, weak Mg \(\text{II}\) systems exhibit the least evolution. Correcting the \(W_0^{2796} < 0.3\) \(\text{Å}\) points for evolution has only a minimal effect on Figure 2 and makes the consistency more robust. Thus, the results from the MMT survey confirm the upturn in \(\partial N/\partial W_0^{2796}\) below 0.3 \(\text{Å}\) that was first identified in NTR05. Figure 3 shows \(W_0^{\text{MMT}}\) determined for systems with \(W_0^{2796} \geq 0.5\) \(\text{Å}\), along with the values from the SDSS EDR survey. The \(W_0^{2796}\) distribution determined from the MMT survey is consistent within the errors with the SDSS EDR survey results, considering the observed redshift evolution.

The distribution of redshifts for Mg \(\text{II}\) absorption systems found in the survey is shown in Figure 4. Also shown is the sight line coverage for \(W_0^{\text{mm}} = 1.0, 0.6,\) and 0.3 \(\text{Å}\). The resulting \(\partial N/\partial z\)
values as a function of look-back time in a \((\Omega_\Lambda, \Omega_M, h) = (0.7, 0.3, 0.7)\) cosmology are shown in Figure 5. The lowest redshift bin corresponds to the range of look-back time not covered by the EDR survey, except for the panels with \(W_0^{2796} \geq 2.0\ \AA\), which did not have enough absorbers to allow for more than a single bin. Also shown are the respective data from the EDR and CRCV99 surveys. The dashed lines are the no-evolution curves normalized to the binned EDR/CRCV99 data, excluding the MMT data. The \(0.367 < z < 0.956\) MMT results are consistent with the other studies. Below \(z \approx 0.4\), the MMT results for systems with \(W_0^{2796} \leq 0.6\) and \(\leq 1.5\ \AA\) are consistent within the large uncertainties with no evolution (however, the EDR results give significant evidence that the incidence of the strongest systems does indeed decrease relative to the no-evolution prediction with decreasing redshift). In addition, the MMT result for \(1.0\ \AA < W_0^{2796} < 1.5\ \AA\) at \(0.195 < z < 0.367\) is significantly \((\approx 1.5\ \sigma)\) below the EDR-normalized no-evolution curve.

NTR05 demonstrated a significant detection of evolution in the incidence of \(W_0^{2796} \geq 2\ \AA\) systems at redshifts \(z \leq 1\). Although our MMT sample is not large enough to confirm this result for \(W_0^{2796} = 1.0\ \AA\), we do detect evolution at lower redshift \((0.195 < z < 0.367)\) for systems with \(1.0 \leq W_0^{2796} < 1.5\ \AA\). Furthermore, the values of \(W^*\) derived from the MMT data (Fig. 3) are consistent with the NTR05 results whereby the evolution of the incidence of \(\text{Mg}\) systems is described by a steepening of \(\partial N/\partial W_0^{2796}\) with decreasing redshift. While \(W^*\) was measured from the SDSS EDR data down to \((z) \approx 0.7\), the MMT data extend this result down to \((z) \approx 0.4\).

4. DISCUSSION

The incidence \(\partial^2 N/\partial W_0^{2796} \partial z\) of absorption systems is proportional to the product of the number density of systems at a given \(W_0^{2796}\) and redshift times their average absorption cross section. For the \(\text{Mg}\) absorbers considered in this work, \(W_0^{2796}\) is more a measure of kinematics than of column density, since many of the kinematically distinct \(2796\) lines comprising an absorber (which are not individually resolved in the EDR or MMT data) are typically saturated. This is particularly the case for intermediate/strong systems. We have shown that the total proper cross section of \(\text{Mg}\) absorbers decreases with cosmic time at a \(W_0^{2796}\)-dependent rate. While the reason for the differential evolution is not yet clear, multiple physically distinct populations/processes contributing to the incidence of lines nonuniformly in \(W_0^{2796}\) would provide an explanation if those populations/processes evolve at different rates.

In NTR05 we discuss evidence for \(\text{Mg}\) absorbers tracing a variety of physical systems. However, the possibility that the observed evolution is to some extent an artifact of an evolving bias due to dust-induced extinction must also be considered. We further discuss these scenarios below.

4.1. Population-dependent Evolution

According to Rigby et al. (2002), the number of individual kinematic components (“clouds”) in a given \(\text{Mg}\) absorber obeys a Poissonian distribution, except for a large excess of single-cloud systems that account for \(\approx 5\%\) weak systems and have their origins in a population of objects and/or processes distinct from stronger absorbers. Indeed, an extrapolation of our exponential fit to \(\partial N/\partial W_0^{2796}\) to systems with \(W_0^{2796} \leq 0.3\ \AA\) accounts for \(\approx 30\%\) of the systems with \(0.02 \leq W_0^{2796} < 0.3\ \AA\) predicted by the CRCV99 results. Thus, it appears that a fraction of
the “weak” absorbers are physically similar to intermediate-strength systems, while the majority (the single-cloud systems) have a different physical nature. While intermediate-strength systems show no evolution to within fairly strong limits over the large range $0.5 < z < 2$ (Fig. 5; also see NTR05 for discussion), there is evidence that the incidence of weak systems exhibits a significant decrease above $z \approx 1$ (Lynch et al. 2006). It should also be noted, however, that most single-cloud systems have $W_0 < 0.1$ Å (the limit of this study). Thus, multicloud weak systems may be in part responsible for the upturn in the range $0.1 \leq W_0 < 0.3$ Å (see also Masiero et al. 2005). These systems have been linked in part to dwarf galaxies (e.g., Zonak et al. 2004).

Imaging studies of intermediate/strong Mg II absorbers (Rao et al. 2003; M. Belfort-Mihalyi et al. 2006, in preparation) have shown these systems to be associated with galaxies that are drawn from a variety of morphological types. In addition, the results of Kacprzak et al. (2005) indicate that, while galaxy orientation shows no correlation with absorption properties, interactions are an important factor in determining the kinematic spread of the absorption in intermediate-strength systems. Unfortunately, only a handful of systems have been studied in depth with complementary imaging/spectroscopy of the absorbing galaxy together with high-resolution spectroscopy to reveal the absorption kinematics. Steidel et al. (2002) have shown that extended rotating disks contribute partially to the incidence in a subset of systems chosen to be associated with inclined spirals. However, the edge-on spiral studied by Ellison et al. (2003) is inconsistent with extended disk absorption. They suggest superbubbles as the cause of the absorption, as postulated by Bond et al. (2001a). The few $W_0 > 3.5$ Å systems for which high-resolution spectroscopy exists show kinematics consistent with the superwind picture (Bond et al. 2001b), although it has also been suggested that galaxy pairs/interactions may contribute to the incidence of such systems (see, e.g., Churchill et al. 2000).

Although the strongest systems have been poorly studied due to their relatively small incidence, there is evidence indicating that the populations and processes associated with these systems differ from those associated with intermediate-strength absorbers. Turnshek et al. (2005; see also Nestor et al. 2003) demonstrate that the average metallicity in Mg II absorbers is strongly correlated

![Fig. 5.—Plots of $\frac{\partial N}{\partial z}$ as a function of look-back time, for a $(\Omega_L, \Omega_M, h) = (0.7, 0.3, 0.7)$ cosmology. The horizontal bars represent bin size and the vertical bars the 1 $\sigma$ uncertainties. Points without symbols are the EDR results, while the circles represent the MMT and crosses the CRCV99 results. The dashed lines are the no-evolution curves normalized to the binned EDR/CRCV99 data, but excluding the MMT data. [See the electronic edition of the Journal for a color version of this figure.]
with absorption kinematics, which suggests that the strongest systems are associated with more massive and/or evolved galaxies. Furthermore, B. Ménard et al. (2006, in preparation) find that the average (over a large number of absorbers) degree to which QSOs are reddened due to foreground Mg II absorbers is strongly \( W'_{2796} \)-dependent for strong systems. Scenarios involving both superwinds and interactions give a natural explanation for the increased metallicity and reddening with increasingly higher redshift. Both superwinds and interactions give a natural explanation for the increased metallicity and reddening with increasingly strong systems. Interactions can both strip gas, causing large line-of-sight velocity spreads (i.e., large \( W'_{2796} \) values), and induce star formation, which in turn enriches the gas. In the superwind picture, relatively highly enriched gas expelled in superwinds dominates in the strongest systems, whereas much of the gas responsible for most intermediate-strength absorbers has remained at large galactocentric distances (impact parameters) since it first condensed.

As mentioned by Heckman (2002), the appearance of superwinds is intimately related to the star formation rate (SFR) per unit area in a galaxy. While Lyman break galaxies (\( z \sim 3 \)) and moderate-redshift (\( 1.4 \leq z \leq 2.5 \)) star-forming galaxies do show evidence of superwinds (Pettini et al. 2001; Shapley et al. 2003; Steidel et al. 2004), the SFR densities of ordinary local spiral galaxies (Kennicutt 1998) are insufficient. The incidence of superwinds should therefore decrease with decreasing redshift, especially at \( z \leq 1 \), since the global SFR decreases below this value (Hopkins 2004 and references therein). The evolution of the galaxy pair-fraction and merger rates is uncertain, however. Some studies have found little evolution over \( 0 < z \leq 1 \) (Lin et al. 2004; Carlbarg et al. 2000), while others have found strong evolution (Le Fèvre et al. 2000).

We have also begun an imaging study of individual “ultra-strong” systems, having \( W'_{2796} \geq 4 \) A. Although the numbers are still quite small, early results suggest that ultrastrong Mg II absorbers may select galaxies that are preferentially bright compared to the field population or those selected by intermediate/strong Mg II absorbers (see Nestor et al. 2005b).

It is unclear, however, how DLAs systems fit into the overall picture. According to Rao et al. (2006) the likelihood of a Mg II absorber having a neutral hydrogen column density above the DLA threshold (\( N_{\text{HI}} \geq 2 \times 10^{20} \)) rises from \( \approx 15\% \) for \( W'_{2796} \approx 0.6 \) A to \( \approx 65\% \) for \( W'_{2796} \approx 3.0 \) A. However, DLAs preferentially select neither bright galaxies, as the “ultrastrong” systems may, nor high-SFR systems (see Hopkins et al. 2005), which are required for superwinds. If the incidences of the DLA, superwind, and interacting/galaxy-pair populations are evolving at a different rate than those for the population/processes traced (at least in part) by the “classic” Mg II absorbers, this should contribute to the differential evolution seen in Mg II absorption. As the role of the DLA subpopulation provides important clues for the study of low-ionization/neutral gas, sorting this out should be an important goal of future work.

4.2. Dust

The differential evolution in \( \partial N/\partial z \) could also be affected by an evolving dust bias. Vladilo & Peroux (2005) claim that extinction from dust increases linearly with Zn column density, from small (\( A_V \leq 0.02 \) mag) levels at \( N_{\text{Zn}} \leq 10^{12} \) to significant levels at higher column densities (\( A_V \approx 0.15 \) mag at \( N_{\text{Zn}} \approx 10^{12.8} \)). The results of Turnshek et al. (2005) indicate that the average Zn column density increases to approximately this level for strong (\( W'_{2796} \approx 3 \) A) Mg II systems. Indeed, the B. Ménard et al. (2006, in preparation) results for \( E(B - V) \) versus \( W'_{2796} \) are roughly consistent with that predicted by Vladilo & Peroux, considering the Turnshek et al. \( W'_{2796}, N_{\text{Zn}} \) relation. Thus, the largest \( N_{\text{Zn}} \) systems (which preferentially correspond to the largest \( W'_{2796} \) values) may be missed due to the background QSOs dropping out of magnitude-limited and/or color-selected surveys such as the SDSS. If this is indeed the case, we expect that the \( W'_{2796}, N_{\text{Zn}} \) relation will level off at large \( W'_{2796} \) as the largest individual \( N_{\text{Zn}} \) systems drop out of the survey. In addition, we would expect a turnover in \( \partial N/\partial W'_{2796} \) at large \( W'_{2796} \) as these systems are preferentially missed. Both of these tests will be possible with larger Mg II absorber catalogs formed from the full SDSS survey. We also note that although recent studies such as those emerging from the CORALS survey (e.g., Ellison et al. 2004) claim to find no dust biases, the size of their survey is not large enough to study the rare, strongest systems.

5. CONCLUSIONS

We have detected and measured 140 Mg II absorption systems in the spectra of 381 QSOs obtained at the MMT Observatory. These data include systems with \( z \geq 2.796 \) rest equivalent width in the range \( 0.1 \leq W'_{2796} \leq 3.2 \) A and extend our determination of the incidence of Mg II absorbers down to redshift \( z = 0.15 \).

Coverage of \( W'_{2796} \) across the value \( W'_{2796} \approx 0.3 \) A is important, since the distribution \( \partial N/\partial W'_{2796} \) is represented very well by a single exponential function above \( W'_{2796} \approx 0.3 \) A but diverges from the fit with an excess of absorbers below this value. This effect was first noted in NTR05 by comparing our SDSS EDR survey data for \( W'_{2796} \geq 0.3 \) A with data from CRCV99 having \( W'_{2796} < 0.3 \) A. Here we confirm the nature of the \( \partial N/\partial W'_{2796} \) distribution in a single survey, thereby removing the concern that the putative upturn was an artifact of unknown systematic differences in the two independent surveys.

By extending the redshift coverage of our Mg II survey to lower redshift, we sample systems down to a look-back time of \( \approx 2 \) Gyr, compared to \( \approx 4 \) Gyr for SDSS samples, and thereby increase the total look-back time covered by \( \approx 2 \) Gyr. The low-redshift regime is of particular importance, especially for intermediate/strong systems, since the apparent evolution in their incidence is easily manifested only at low redshift. While NTR05 report evolution in systems with \( W'_{2796} \approx 2.0 \) A at redshifts \( z \approx 1 \), we now detect evidence for evolution in systems with \( W'_{2796} \approx 1.0 \) A at redshifts \( z \approx 0.5 \). The evolution apparent in our MMT sample is consistent with the nature of the evolution described in NTR05, whereby the incidence decreases from the no-evolution prediction (i.e., the total proper absorption cross section decreases) at a rate dependent on \( W'_{2796} \).

It seems likely that multiple populations and processes contribute to the total cross section of Mg II absorption in a \( W'_{2796} \)-dependent manner and that the different evolutionary rates of these populations and processes lead to the \( W'_{2796} \)-dependent evolution in \( \partial N/\partial z \). It is also possible, however, that biases due to dust-induced extinction give rise to the detected evolution. It will be necessary to determine the relative contribution of the various physically distinct components/processes to the incidence of Mg II systems, as well as obtain stronger constraints on the evolution of the incidence, in order to better understand low-ionization/neutral gas absorption systems. Determining the relative contribution as a function of \( W'_{2796} \) will help us further

4 Note that since these are averages, some systems are expected to have larger Zn columns, even at smaller \( W'_{2796} \) values.

5 However, the presence of a turnover, if found, could also be explained by a physical upper limit to the velocity spread of Mg II absorbers.
understand the evolution in time of each type (and, perhaps, vice versa). The results of our ongoing studies, such as the imaging of “ultrastrong” systems and the analysis of the full SDSS sample, are two such projects that should add to our understanding of the nature and evolution of these systems.

We acknowledge support for this work from the NSF. We also acknowledge Brice Ménard for helpful discussions and ongoing collaborations related to this work, and we thank the MMT staff and the members of the SDSS collaboration who made our observing runs and the SDSS project a success.

REFERENCES

Bergeron, J., & Boisse, P. 1991, A&A, 243, 344
Bond, N. A., Churchill, C. W., Charlton, J. C., & Vogt, S. S. 2001a, ApJ, 557, 761
———, 2001b, ApJ, 562, 641
Carlberg, R. G., et al. 2000, ApJ, 532, L1
Churchill, C. W., Kacprzak, G. G., & Steidel, C. C. 2005, in IAU Colloq. 199, Probing Galaxies through Quasar Absorption Lines, ed. P. R. Williams, C. Shu, & B. Ménard (Cambridge: Cambridge Univ. Press), 24
Churchill, C. W., Mellon, R. R., Charlton, J. C., Jannuzi, B. T., Kirhakos, S., Steidel, C. C., & Schneider, D. P. 2000, ApJ, 543, 577
Churchill, C. W., Rigby, J. R., Charlton, J. C., & Vogt, S. S. 1999, ApJS, 120, 51 (CRCV99)
Ding, J., Charlton, J. C., & Churchill, C. W. 2005, ApJ, 621, 615
Ellison, S. L., Churchill, C. W., Rix, S. A., & Pettini, M. 2004, ApJ, 615, 118
Ellison, S. L., Mallén-Ornelas, G., & Sawicki, M. 2003, ApJ, 589, 709
Heckman, T. M. 2002, in ASPConf. Ser. 254, Extragalactic Gas at Low Redshift, ed. J. S. Mulchaey & J. T. Stocke (San Francisco: ASP), 292
Hopkins, A. M. 2004, ApJ, 615, 209
Hopkins, A. M., Rao, S. M., & Turnshek, D. A. 2005, ApJ, 630, 108
Kacprzak, G. G., Churchill, C. W., & Steidel, C. C. 2005, in IAU Colloq. 199, Probing Galaxies through Quasar Absorption Lines, ed. P. R. Williams, C. Shu, & B. Ménard (Cambridge: Cambridge Univ. Press), 80
Kennicutt, R. C., Jr. 1998, ApJ, 498, 541
Lanzetta, K. M., Turnshek, D. A., & Wolfe, A. M. 1987, ApJ, 322, 739
Le Fèvre, O., et al. 2000, MNRAS, 311, 565
Lin, L., et al. 2004, ApJ, 617, L9
Lynch, R. S., Charlton, J. C., & Kim, T. 2006, ApJ, 640, 81
Masiero, J. R., Charlton, J. C., Ding, J., Churchill, C. W., & Kacprzak, G. 2005, ApJ, 623, 57
Nestor, D. B., Rao, S. M., Turnshek, D. A., & Vanden Berk, D. 2003, ApJ, 595, L5
Nestor, D. B., Turnshek, D. A., & Rao, S. M. 2005a, ApJ, 628, 637 (NTR05)
———, 2005b, in IAU Colloq. 199, Probing Galaxies through Quasar Absorption Lines, ed. P. R. Williams, C. Shu, & B. Ménard (Cambridge: Cambridge Univ. Press), 92
Pettini, M., Shapley, A. E., Steidel, C. C., Cuby, J.-G., Dickinson, M., Moorwood, A. F. M., Adelberger, K. L., & Giavalisco, M. 2001, ApJ, 554, 981
Rao, S. M., Nestor, D. B., Turnshek, D. A., Lane, W. M., Monier, E. M., & Bergeron, J. 2003, ApJ, 595, 94
Rao, S. M., Turnshek, D. A., & Nestor, D. B. 2006, ApJ, 636, 610
Rigby, J. R., Charlton, J. C., & Churchill, C. W. 2002, ApJ, 565, 743
Sargent, W. L. W., Boksenberg, A., & Steidel, C. C. 1988, ApJS, 68, 539
Shapley, A. E., Steidel, C. C., Pettini, M., & Adelberger, K. L. 2003, ApJ, 588, 65
Steidel, C. C., Kollmeier, J. A., Shapley, A. E., Churchill, C. W., Dickinson, M., & Pettini, M. 2002, ApJ, 570, 526
Turnshek, D. A., Rao, S. M., Belfort-Mihalyi, M., & Quider, A. 2005, in IAU Colloq. 199, Probing Galaxies through Quasar Absorption Lines, ed. P. R. Williams, C. Shu, & B. Ménard (Cambridge: Cambridge Univ. Press), 104
Tytler, D., Boksenberg, A., Sargent, W., Young, P., & Kunth, D. 1987, ApJS, 64, 667
Vladilo, G., & Peroux, C. 2005, A&A, 444, 461
Weymann, R. J., Williams, R. E., Peterson, B. M., & Turnshek, D. A. 1979, ApJ, 234, 33
Zonak, S. G., Charlton, J. C., Ding, J., & Churchill, C. W. 2004, ApJ, 606, 196