A SURVEY OF INTRINSIC ABSORPTION IN ACTIVE GALAXIES USING THE FAR ULTRAVIOLET SPECTROSCOPIC EXPLORER

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ABSTRACT

We present a survey of 72 Seyfert galaxies and quasars observed by the Far Ultraviolet Spectroscopic Explorer. We have determined that 72 of 253 available active galactic nuclei (AGNs) targets are viable targets for detection of intrinsic absorption lines. We examined these spectra for signs of intrinsic absorption in the O vi doublet ($\lambda$1031.9, 1037.6) and Lyβ ($\lambda$1025.7). The fraction of Seyfert 1 galaxies and low-redshift quasars at $z \leq 0.15$ that show evidence of intrinsic UV absorption is $\sim$50%, which is slightly lower than that found by Crenshaw et al. (1999), who found 60% based on a smaller sample of Seyfert 1 galaxies observed with the Hubble Space Telescope. With this new fraction we find a global covering factor of the absorbing gas with respect to the central nucleus of $\sim$0.4. Our survey is to date the largest search for intrinsic UV absorption with high spectral resolution and is the first step toward a more comprehensive study of intrinsic absorption in low-redshift AGNs.

Key words: galaxies: Seyfert — ultraviolet: galaxies

1. INTRODUCTION

Seyfert galaxies are relatively nearby, mostly spiral galaxies that host active galactic nuclei (AGNs). Intensive studies over the past few decades lead us to believe that a supermassive black hole with an accretion disk lies at the core of every active galaxy and is the engine driving the activity. Seyfert galaxies, unlike quasars, are typically close, with redshifts $z \leq 0.1$, and have moderate bolometric luminosities ($10^{45}$ ergs s$^{-1}$). Over timescales ranging from days to years Seyfert galaxies show variation in continuum luminosity over a factor of $\sim$10 in amplitude (Dunn et al. 2006). Seyfert galaxies are divided into two basic categories, 1 and 2 (Kachikian & Weedman 1974). Seyfert 1 galaxies show both broad permitted emission lines and narrow permitted and forbidden lines, while the UV and optical spectra of Seyfert 2 galaxies are devoid of broad emission features in unpolarized light.

Oke & Sargent (1968) found that while the optical spectra of Seyfert galaxies have absorption features, which were previously attributed as stellar, there was an He i line in NGC 4151 that was likely due to self-absorption. Anderson & Kraft (1969) found three kinematic components within the He i and hydrogen Balmer absorption lines that showed blueshifts relative to the rest frame of up to 970 km s$^{-1}$. They attributed these features to an outflow of gas from the core with multiple kinematic components.

Cromwell & Weymann (1970) showed that the absorption was variable. Ulrich & Boisson (1983) found in data from the International Ultraviolet Explorer (IUE) that only 3%–10% of Seyfert galaxies showed intrinsic absorption in high-ionization lines (C iv, N v, and O vi). Crenshaw et al. (1999) found in an HST study that this number was far too low due to the low resolution of IUE and that the percentage of Seyfert galaxies that showed intrinsic C iv absorption was closer to 60%. This, however, was not a large survey, only 17 objects, possibly with some selection biases. It did show that intrinsic absorption was much more prominent in Seyfert 1 galaxies than previously thought and that further study is required of this phenomenon to more fully understand the central engine in AGNs. Crenshaw et al. also showed a 1:1 relationship between the warm X-ray absorbers (George et al. 1998; Reynolds 1997) and intrinsic UV absorption in Seyfert galaxies. They also estimated a global covering factor for Seyfert galaxies of $\sim$0.5. Laor & Brandt (2002) surveyed 50 AGNs that included both quasars and Seyfert galaxies. Their survey found that 44% showed C iv absorption with an equivalent width greater than 0.1 Å.

In a recent review article, Crenshaw et al. (2003) found that while there have been many advances in the field of intrinsic absorption, the need for further examination of mass outflow properties in AGNs is necessary. We need to have a larger survey of AGNs to investigate the effects of luminosity, AGN type, radio power, orientation, and accretion rate. Also, there is a need to determine transverse velocities of the intrinsic absorbing clouds (as seen in Kraemer et al. 2001). These factors will help constrain dynamical models currently being considered as explanations of the origin of the mass outflow. This paper is the first in a series designed to further our understanding of these characteristics. The main goal of the paper is to present the spectra, component identifications, and the frequency of occurrence of intrinsic absorption.

2. SURVEY

Our survey is more than 4 times larger than that of Crenshaw et al. (1999) and is taken from the available FUSE data at the Multimission Archives at Space Telescope (MAST). FUSE is ideal for intrinsic absorption studies in AGNs due to the wavelength coverage (905–1187 Å) that allows for the O vi doublet ($\lambda$1031.9, 1037.6) and Lyβ ($\lambda$1025.7) to be detected at low redshifts. FUSE also lends itself to this work because of its resolution, approximately 15 km s$^{-1}$ (FWHM), allowing us to find narrow absorption features and resolve structure in broader features.

FUSE comprises four mirrors and four gratings split onto two detectors (Sahnow 2002). This provides eight different spectra per observation. One set uses a LiF coating, while the other

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| Object       | R.A. (J2000.0) | Decl. (J2000.0) | z  | Classa | S/N | Observation ID   | Observation Date | Exposure Time |
|--------------|----------------|-----------------|----|--------|-----|-----------------|------------------|---------------|
| Mrk 335      | 00 06 19.53    | +20 12 10.3     | 0.026 | Sy 1.2 | 54.9 | P1010204000     | 2000 Nov 21      | 53391         |
| QSO 0045+3926| 00 48 18.90    | +39 41 12.0     | 0.134 | Sy 1    | 9.6  | D1310101000     | 2003 Oct 8       | 42658         |
|              |                |                 |      |         |      | D1310105000     | 2004 Nov 25      | 25452         |
|              |                |                 |      |         |      | D1310106000     | 2004 Nov 26      | 27487         |
|              |                |                 |      |         |      | D1310104000     | 2003 Dec 9       | 40728         |
|              |                |                 |      |         |      | D1310107000     | 2004 Nov 27      | 25058         |
|              |                |                 |      |         |      | D1310102000     | 2003 Oct 10      | 34371         |
| I Zw 1       | 00 53 34.90    | +12 41 36.0     | 0.061 | Sy 1    | 3.8  | P1110101000     | 1999 Dec 3       | 13584         |
| Ton S180     | 00 57 19.95    | −22 22 59.3     | 0.062 | Sy 1.2  | 14.0 | D1310103000     | 2003 Oct 11      | 16644         |
| Mrk 352      | 00 59 53.28    | +31 49 36.7     | 0.015 | Sy 1    | 7.3  | D1310104000     | 2003 Dec 9       | 6321          |
| RX J010027−511346 | 01 00 27.06 | −51 13 54.8   | 0.063 | Sy 1    | 2.5  | D1310104000     | 2003 Dec 9       | 6321          |
| Ton S210     | 01 21 51.56    | −28 20 57.3     | 0.116 | Sy 1    | 23.0 | P1070101000     | 1999 Oct 21      | 14023         |
| Fairall 9    | 01 23 46.04    | −58 47 23.8     | 0.047 | Sy 1.2  | 15.4 | P1070101000     | 2000 Jul 3       | 34896         |
| Mrk 1044     | 02 30 05.45    | −08 59 52.6     | 0.016 | Sy 1    | 7.3  | D104101000      | 2004 Jan 1       | 12608         |
| NGC 985      | 02 34 37.77    | −08 47 15.6     | 0.043 | Sy 1    | 29.4 | D104101000      | 2004 Jan 1       | 12608         |
| ESO 31-8     | 03 07 35.30    | −72 50 06.2     | 0.028 | Sy 1    | 3.3  | D104101000      | 2004 Jan 1       | 12608         |
| EUVE J0349−537 | 03 49 28.50 | −53 44 70.0 | 0.130 | Sy 1.2  | 14.0 | D104101000      | 2004 Jan 1       | 12608         |
| IRAS F04250−5718 | 04 26 00.83 | −57 12 00.4 | 0.104 | Sy 1    | 2.1  | D104101000      | 2004 Jan 1       | 12608         |
| Fairall 303  | 04 30 40.02    | −53 36 55.9     | 0.040 | Sy 1    | 3.1  | D104101000      | 2004 Jan 1       | 12608         |
| Mrk 618      | 04 36 22.25    | −10 22 33.9     | 0.036 | Sy 1    | 3.2  | D104101000      | 2004 Jan 1       | 12608         |
| Ark 120      | 05 16 11.42    | −00 08 59.4     | 0.033 | Sy 1    | 12.2 | P1070101000     | 2000 Jul 3       | 34896         |
| PKS 0558−504 | 05 59 47.40    | −50 26 52.0     | 0.137 | NL      | 18.4 | C1490601000     | 2002 Nov 7       | 48480         |
| IRAS L06229−6434 | 06 23 09.10 | −64 36 24.0 | 0.129 | Sy 1    | 2.9  | D9030304000     | 2003 Dec 17      | 44494         |
| VII Zw 118   | 07 07 13.10    | +64 35 58.8     | 0.080 | Sy 1    | 11.6 | P1011606000     | 2000 Jan 1       | 9805          |
| I H 0707−495 | 07 08 41.50    | +49 33 05.8     | 0.041 | Sy 1    | 12.8 | P1011605000     | 1999 Oct 6       | 77568         |
| Mrk 9        | 07 36 57.02    | +58 46 13.4     | 0.040 | Sy 1.5  | 5.3  | P1011604000     | 1999 Oct 6       | 77568         |
| Mrk 79       | 07 42 32.80    | +49 48 34.9     | 0.022 | Sy 1.2  | 3.0  | P1011701000     | 2000 Jan 2       | 11688         |
| Mrk 10       | 07 47 29.10    | +60 56 01.0     | 0.029 | Sy 1    | 2.7  | P1011701000     | 2000 Feb 22      | 12498         |
| IR 07546+3928 | 07 58 00.05 | +39 20 29.1 | 0.096 | Sy 1.5  | 6.7  | Z9072801000     | 2003 Feb 2       | 22699         |
| PG 0804+761  | 08 10 58.46    | +76 02 41.9     | 0.100 | Sy 1    | 28.3 | S6011008000     | 2002 Nov 27      | 36886         |

**TABLE 1**

AGNs Included in the Survey
| Object          | R.A. (J2000.0) | Decl. (J2000.0) | z   | S/N | Observation ID | Observation Date | Exposure Time |
|-----------------|---------------|----------------|-----|-----|----------------|------------------|---------------|
| UGC 4305        | 08 19 12.90   | +70 43 06.0    | 0.001 | Sy 1 | F0270104000    | 2005 Dec 20     | 11.1          |
| PG 0838+770     | 08 44 45.26   | +76 53 10.0    | 0.132 | Sy 1 | F0270102000    | 2005 Dec 18     | 18821         |
| Ton 951         | 08 47 42.60   | +34 45 04.7    | 0.064 | Sy 1 | F0270103000    | 2006 Feb 10     | 75047         |
| IRAS 09149−62   | 09 16 09.41   | −62 19 29.5    | 0.057 | Sy 1 | S7011002000    | 2005 Mar 31     | 14520         |
| Mrk 110         | 09 25 12.87   | +52 17 10.7    | 0.035 | Sy 1 | P1071302000    | 2006 Feb 9      | 10791         |
| Ton 1187        | 10 13 03.21   | +35 51 22.2    | 0.079 | Sy 1 | P1071502000    | 2000 Jan 13     | 7994          |
| PG 1011−040     | 10 14 20.58   | −04 18 41.2    | 0.058 | Sy 1 | B0790101000    | 2001 May 16     | 85197         |
| Mrk 141         | 10 19 12.59   | +63 58 02.7    | 0.042 | Sy 1 | B0601001000    | 2002 Apr 28     | 11487         |
| Mrk 142         | 10 25 31.28   | +51 40 34.9    | 0.045 | Sy 1 | B0601001000    | 2003 Mar 23     | 20103         |
| IRAS 09149/C062 | 09 16 09.41   | +70 43 06.0    | 0.001 | Sy 1 | S7011003000    | 2005 Mar 30     | 13648         |
| Mrk 110         | 09 25 12.87   | +52 17 10.7    | 0.035 | Sy 1 | P1071302000    | 2006 Feb 9      | 10791         |
| Ton 1187        | 10 13 03.21   | +35 51 22.2    | 0.079 | Sy 1 | P1071502000    | 2000 Jan 13     | 7994          |
| PG 1011−040     | 10 14 20.58   | −04 18 41.2    | 0.058 | Sy 1 | B0790101000    | 2001 May 16     | 85197         |
| Mrk 141         | 10 19 12.59   | +63 58 02.7    | 0.042 | Sy 1 | B0601001000    | 2002 Apr 28     | 11487         |
| Mrk 142         | 10 25 31.28   | +51 40 34.9    | 0.045 | Sy 1 | B0601001000    | 2003 Mar 23     | 20103         |
| IRAS 09149/C062 | 09 16 09.41   | +70 43 06.0    | 0.001 | Sy 1 | S7011003000    | 2005 Mar 30     | 13648         |
| Mrk 734         | 11 21 47.11   | +11 44 18.5    | 0.050 | Sy 1 | B1071003000    | 2001 Apr 16     | 4587          |
| NGC 3738        | 11 39 01.78   | −37 44 18.5    | 0.010 | Sy 1 | B1071003000    | 2001 May 11     | 27221         |
| IR 1143−1810    | 11 45 40.48   | −18 27 15.3    | 0.033 | Sy 1 | B1071003000    | 2001 May 11     | 27221         |
| NGC 4051        | 12 03 09.61   | +44 31 32.8    | 0.002 | Sy 1 | B0602010000    | 2002 Mar 29     | 28659         |
| NGC 4151        | 12 10 32.60   | +39 24 21.0    | 0.003 | Sy 1 | B0601001000    | 2001 Jan 27     | 27483         |
| PG 1211+143     | 12 14 17.61   | +14 03 12.7    | 0.081 | Sy 1 | B1072001000    | 2000 Apr 25     | 52274         |
| Mrk 205         | 12 21 44.04   | +75 18 38.3    | 0.071 | Sy 1 | S6010801000    | 2002 Feb 2      | 16027         |
| PG 1351+640     | 13 53 15.80   | +63 45 45.0    | 0.088 | Sy 1 | S6010701000    | 2002 Feb 1      | 48620         |
| Mrk 279         | 13 53 03.52   | +69 18 29.7    | 0.030 | Sy 1 | P1072501000    | 2000 Jan 18     | 70134         |

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uses a SiC coating. The LiF coating provides a reflectivity nearly twice that of the SiC at wavelengths greater than 1050 Å. In nearly every spectrum, this implies a better signal-to-noise ratio across the LiF spectrum in the region of interest. We downloaded the raw data for all of the targets we selected and processed them using CalFUSE, version 3.1, in time-tag mode (Dixon et al. 2002). We co-added seven of the eight spectra into one spectrum weighted by exposure time. We did not include the LiF 1b segment in the co-added spectrum. We intentionally omitted this because of a distortion which is significant with a resolution of 15 km s$^{-1}$. However, our survey’s initial purpose is to find Seyfert galaxies that exhibit intrinsic absorption and provide approximate velocity centroids. In a subsequent paper, we will present measured velocities and velocity widths for all available absorption lines. Also, we will provide a good estimate of the velocity error for any given spectrum based on the position of various ISM lines seen in spectra on a target-by-target basis.

Our list of targets originated from the category listing on the MAST Web site. We took all targets listed by observers as Seyfert galaxies or as quasars (253 targets). Using the NASA Extragalactic Database (NED) we narrowed the total list to 143 objects by eliminating any targets that had a redshift greater than $z = 0.15.$ However, our survey’s initial purpose is to find Seyfert galaxies that exhibit intrinsic absorption and provide approximate velocity centroids. In a subsequent paper, we will present measured velocities and velocity widths for all available absorption lines. Also, we will provide a good estimate of the velocity error for any given spectrum based on the position of various ISM lines seen in spectra on a target-by-target basis.

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### TABLE 1—Continued

| Object       | R.A. (J2000.0) | Decl. (J2000.0) | z  | Class$^a$ | S/N | Observation ID       | Observation Date | Exposure Time (s) |
|--------------|---------------|----------------|----|-----------|-----|----------------------|------------------|-------------------|
| RX J135515+561244...| 13 55 16.55   | +56 12 44.6    | 0.122 | Sy 1     | 1.78 | D8061601000          | 2003 Mar 13      | 47223             |
| PG 1404+526      | 14 06 22.15   | +22 23 42.8    | 0.098 | Sy 1     | 1.86 | P2100401000          | 2001 Jun 11      | 11489             |
| PG 1411+442      | 14 13 48.32   | +44 00 13.1    | 0.090 | Sy 1     | 2.64 | A0601010000          | 2000 May 11      | 7360              |
| PG 1415+451      | 14 17 00.84   | +44 56 0.6     | 0.114 | Sy 1     | 2.47 | A0601110000          | 2000 May 10      | 12285             |
| NGC 5548...     | 14 17 59.91   | +25 08 12.6    | 0.017 | Sy 1.5   | 11.11 | D1550102000         | 2004 Feb 11      | 7757              |
| Mrk 1383...     | 14 29 06.60   | +01 17 06.6    | 0.086 | Sy 1     | 22.27 | P1014801000          | 2001 Feb 18      | 11219             |
| Mrk 817...      | 14 36 22.09   | +58 47 39.5    | 0.031 | Sy 1.5   | 49.78 | D1550102000         | 2004 Feb 11      | 7757              |
| Mrk 477...      | 14 40 38.06   | +53 30 15.7    | 0.038 | Sy 1     | 7.25  | P1110808000          | 2001 May 8       | 11289             |
| Mrk 478...      | 14 42 07.46   | +35 26 22.9    | 0.079 | Sy 1     | 1.86  | P1110909000          | 2001 Jan 29      | 14118             |
| Mrk 290...      | 15 35 52.38   | +57 54 0.9     | 0.030 | Sy 1     | 5.53  | D0760101000          | 2003 Jun 28      | 9239              |
| Mrk 506...      | 17 22 39.92   | +30 52 53.1    | 0.043 | Sy 1     | 4.34  | D0760102000          | 2004 Feb 27      | 46032             |
| 3C 382...       | 18 35 03.38   | +32 41 47.0    | 0.058 | Sy 1     | 3.15  | D0760102000          | 2004 Feb 27      | 46032             |
| PKS 2005-489... | 20 09 25.39   | -48 49 3.7     | 0.071 | QSO      | 6.97  | D1490301000          | 2002 Apr 12      | 24726             |
| Mrk 509...      | 20 44 09.74   | -10 43 24.7    | 0.034 | Sy 1.2   | 42.83 | D1490302000          | 2002 Jun 4       | 13422             |
| II Zw 136...    | 21 32 27.83   | +10 08 19.4    | 0.063 | Sy 1     | 11.55 | D1080601000          | 2000 Sep 5       | 60656             |
| Mrk 304...      | 22 17 12.28   | +14 14 20.9    | 0.066 | RQQ      | 3.05  | P1080401000          | 2000 Nov 14      | 22629             |
| Ark 564...      | 22 42 39.34   | +29 43 31.3    | 0.025 | Sy 1.8   | 6.19  | B0620101000          | 2001 Jun 29      | 55515             |
| IRAS F22456-5125.. | 22 48 41.00  | -51 09 54.0    | 0.100 | Sy 1     | 6.82  | Z0973902000          | 2002 Sep 24      | 31301             |
| MR 2251-178...  | 22 54 05.80   | -17 34 55.0    | 0.064 | Sy 1     | 16.13 | Z0973901000          | 2002 Sep 24      | 5534              |
| NGC 7469...     | 23 03 15.62   | +08 52 25.6    | 0.016 | Sy 1.2   | 2.22  | C0900101000          | 2002 Dec 13      | 3593              |

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$^a$ AGN types listed in the NASA Extragalactic Database.

$^b$ Reduced from a possible S/N of 3.34.

$^c$ No AGN type listed.

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See http://nedwww.ipac.caltech.edu/index.html.
Any target with a redshift greater than this places the O \textsc{vi} doublet outside of the wavelength coverage for \textit{FUSE}. We have retained these data for possible further analysis of the C \textsc{iii} line ($\lambda$977.03) and the N \textsc{ii} ($\lambda$989.79) line.

We narrowed the list further to 122 objects by removing any galaxy that had a type listed in NED other than Seyfert 1 or quasar; note that we still examined the spectra of these targets, but these were not included in the survey. We include only Seyfert 1 galaxies or quasars because detection of intrinsic absorption requires a strong background source (i.e., continuum and broad-line region).

One interesting target that we removed is WPVS 007. According to K. Leighly et al. (2007, in preparation), this Seyfert galaxy has evolved to a broad absorption line miniquasar. Thus, we have eliminated it from our list, although it has been known to show narrow intrinsic absorption lines in previous observations (Crenshaw et al. 1999).

The last criterion that we applied to the data was a signal-to-noise ratio cutoff. By using the provided noise vector with the data we found a good cutoff for the signal-to-noise ratio per resolution element ($\sim 15$ km s$^{-1}$ FWHM) of 1.5 across the span 1050–1100 Å. Although this value appears to be low, there are many resolution elements across a typical intrinsic absorption line. In this region we have data from the LiF portion of the spectrograph, as well as data from the SiC portion, co-added to give a good overall estimate of the quality of the spectrum.

Table 1 lists our 72 AGNs used in the survey. We list the signal-to-noise ratio we found in this region for a co-added spectrum per object in Table 1. We also provide a list of the observations available per object in Table 1. In the case of NGC 3516 we did not use all available observations. We chose to use only the 2000 observation, ID P1110404, the LiF portion of the 2006 February observation, and the 2007 January observation in our co-added spectrum. This set of spectra has a lower signal-to-noise ratio, 1.9, than the total co-added spectrum, but these observations have no O \textsc{i} geocoronal dayglow interference, which is heavy in the O \textsc{vi} region of the spectrum.

3. ABSORPTION DETECTION

3.1. Identification

In order to determine which lines are truly intrinsic versus which lines originate in our Galaxy’s ISM, we used a program that provided a synthetic H$_2$ spectrum (Tumlinson et al. 2002), which we overlaid on our velocity plots. As an example, Figure 1 shows the spectrum of IRAS F04250−5718. We have the blue member and red member of the O \textsc{vi} doublet and the Ly$\beta$ lines in respective order from top to bottom plotted in velocity space. The dashed line is the overlaid H$_2$ synthetic spectrum from the Tumlinson code, and the other lines are ISM lines, taken from Morton (1991), scaled to their oscillator strength. The program requires H$_2$ columns to be input for each rovibrational level of the molecule. For detection purposes we input exceptionally high values for the column for each rovibrational level (lower angular momentum level $J = 0$ through 7), on the order of $10^{19}$ cm$^{-2}$. This was to remove any speculation as to whether a line was truly H$_2$ in origin or intrinsic to the AGN/host galaxy. For H$_2$ lines that were coincident with a possible intrinsic absorption feature, we examined nearby H$_2$ lines for both number and strength to place estimates on the contamination.

Another factor that presented problems was geocoronal dayglow emission lines. These are background lines from Earth’s atmosphere that appear as narrow emission lines, which can have peak flux levels several times that of the surrounding continuum spectrum (Feldman et al. 2001). These lines are strong when \textit{FUSE} is observing during the orbit day at low-Earth approach. One example is seen in NGC 4151 as Ly$\beta$ and O \textsc{i} dayglow near 1025 Å in Figure 2.

We visually examined the spectra for lines that did not match the H$_2$ synthetic spectra or the ISM lines. These were flagged for further examination. We identified clean absorption features that had components at approximately the same velocity in at least two of the available lines (the two members of the O \textsc{vi} doublet and Ly$\beta$). Any absorption line that aligned in velocity space for two of the three available lines with at least 2 $\sigma$ in equivalent width was identified as intrinsic absorption. We recorded their approximate velocity centroids, which we provide in Table 2. An example is IRAS F04250−5718. We can see in Figure 1 for IRAS F04250−5718 that intrinsic absorption appears in all three at relatively the same velocity, with one broad component ranging between $-300$ and $-100$ km s$^{-1}$ and an additional component at approximately $-100$ km s$^{-1}$.

A handful of targets are still enigmas. These few targets show unexplained lines, but either do not agree in velocity or are possibly contaminated by ISM. Any that only contained one line or highly questionable lines were discarded as nonabsorbers. We provide a target-by-target explanation in Appendix A.

3.2. Comparison

There have been two previous surveys of intrinsic UV absorption in low-$z$ AGNs, Crenshaw et al. (1999) and the preliminary survey by Kriss (2002). Crenshaw et al. had 17 targets in their C \textsc{iv} survey of data from the Faint Object Spectrograph (FOS) and the Goddard High-Resolution Spectrograph (GHRS). In the paper they labeled each of the targets as absorbers or nonabsorbers, and we agree on all but one target of the 17, I Zw 1. Kriss had 16 targets that he identified with \textit{FUSE} spectra as intrinsic absorbers. We disagree on three of the targets, I Zw 1, Mrk 304, and Mrk 478.

I Zw 1 is a weak C \textsc{iv} absorber in the spectrum taken by FOS. In the \textit{FUSE} observation, I Zw 1 is in a low flux state. Thus, the O \textsc{vi} absorption lines may be present, but we label this target as a nonabsorber because the potential lines are much like the surrounding noise. There is a line at approximately 1800 km s$^{-1}$, but we only see...
It clearly in the O vi blue member. The other two are contaminated by H₂. Mrk 304 and Mrk 478 have both been categorized as absorbers by Kriss (2002), but in our observations we find that Mrk 304 is only a possible absorber, and does not fit our conservative criteria. Mrk 478 shows no lines that cannot be explained by ISM contamination. Mrk 304 shows a possible line at 1800 km s\(^{-1}\), but it only weakly in the O vi red member and Ly/β. Thus, by our standards, this object is only a possible absorber, and we do not include it as a firm detection. While NGC 7469 is a well-known intrinsic absorber, the signal-to-noise ratio of NGC 7469 combined with heavy H₂ contamination lead to a problematic spectrum.

Another survey we tested against was Laor & Brandt (2002), which used mostly HST data. While they had a broad range of redshifts and object types, there were 14 objects that appeared in both of the studies. Of these 12 objects we agreed on 9. One object appears in both studies, but the signal-to-noise ratio in the FUSE.

**Fig. 2.**—All of the spectra for the targets we identified as intrinsic absorbers. The spectra are plotted in the observed frame, and kinematic components of intrinsic absorption in the lines of Ly/β (λ1025.7) and O vi (λλ1031.9, 1037.6) are numbered. Broad components are indicated by brackets. Strong narrow emission lines are geocoronal. The dashed line represents the synthetic H₂ spectrum. The specific velocity positions can be found in Table 2.
spectrum is too low for our study. Once again I Zw 1 and Mrk 304 are not absorbers on our list, but Laor & Brandt have classified them as absorbers. Mrk 290, however, is listed by Laor et al. as a non-absorber, while we see a distinct absorbing feature at approximately 200 km s⁻¹.

4. CONCLUSIONS

For our final count we find, of the 72 AGNs with reasonably good signal-to-noise ratios, that 35 are intrinsically absorbing, with 11 new detections. Crenshaw et al. (1999) found approximately 60% of their sample showed intrinsic absorption. In our survey, we find that 49% are absorbers. This could very well be a lower bound on the value due to the number of observations where the exposure times were not long enough to obtain a good signal-to-noise ratio for the object. So the sample may be slightly biased toward detecting absorption in AGNs that are brighter in the far-UV.

An important quantity to be determined is the global covering factor, which is the fraction of the sky covered by the ensemble
TABLE 2
OBJECTS WITH INTRINSIC ABSORPTION IN THE SURVEY

| Object          | Component Velocities (km s\(^{-1}\)) |
|-----------------|--------------------------------------|
| QSO 045+3926    | +340                                 |
| Ton S180       | -1800                                |
| Mrk 1044        | -1100, -270                          |
| NGC 985         | -700, -410, -290                     |
| EUVE J0349-537  | 0                                    |
| IRAS F04250-5718| -200, -100, -20                      |
| Mrk 79          | -1400, -320                          |
| Mrk 10          | -150, -200                           |
| IR 07546+3928   | -1800, -1200                         |
| PG 0804+761     | +700                                 |
| Ton 951         | +160                                 |
| IRAS 09149-62   | 0                                    |
| Mrk 141         | -600                                 |
| NGC 3516        | -1320, -830, -370, -180, -60         |
| ESO 265-G23     | -150, +900                           |
| NGC 3783        | -700                                 |
| NGC 4051        | -300                                 |
| NGC 4151        | -500                                 |
| RX J1230.8+0115 | -3000, -2000, +400                   |
| Tol 1238-364    | -200                                 |
| PG 1351+640     | -1800, -1000                         |
| Mrk 279         | -450, -280                           |
| RX J135515+561244| -990, -780, -220, -110, 0           |
| PG 1404+226     | -290, -20, +150                      |
| PG 1411+442     | -50, +80                             |
| NGC 5548        | -700, -480                           |
| Mrk 817         | -4100                                |
| Mrk 290         | -220                                 |
| Mrk 876         | -3800                                |
| Mrk 509         | -400, -290, -10, +120, +200          |
| II Zw 136       | -1500, +20                           |
| Ark 564         | -250, 0                              |
| IRAS F22456-5125| -350, -150, +100, +150, +350         |
| MR 2251-178     | -2000 or -300                        |
| NGC 7469        | -1900                                |

of absorbers as seen from the nucleus. This quantity is useful in helping us understand the geometry of the nucleus and the absorbing region; \( C_g = F(C_f) \), where \( F \) is the fraction of galaxies that show intrinsic absorption and \( C_f \) is the covering factor in the line of sight for the deepest component, averaged over all AGNs with absorption. To estimate \( C_f \) for each individual AGN, we measured the residual flux \( (F_c) \) in the core of the deepest line. Assuming the component is saturated and the residual flux is therefore unabsorbed continuum plus broad-line region flux \( (F_c) \), then \( C_f = (1 - F_c/F_r) \). If the core is not saturated, which is unlikely in most cases, the value of \( C_f \) that we derived is actually a lower limit. Crenshaw et al. 1999 found \( (C_f) \approx 0.85 \), and for the FUSE data we find that \( (C_f) \approx 0.86 \), very similar in both UV and far-UV. So using \( (C_f) \approx 0.86 \) with \( F \approx 0.49 \) we find a global covering factor of \( C_g = 0.42 \).

This measurement has also been made for other AGN samples. Ganguly et al. (2001) found a fraction of only 0.25 for C iv absorption in quasars with \( z < 1.0 \), while the Laor & Brandt (2002) study found \( F = 0.50 \) for Seyfert galaxies and quasars up to redshifts of 0.5. George et al. (2000) found \( F = 0.3 \) for X-ray absorption in low-z quasars, and Vestergaard (2003) found \( F = 0.55 \) for quasars between 1.5 and 3.5 in redshift for C iv absorption. So for several luminosities and a wide range of redshifts, most surveys find values for \( F \) around 0.5.

In our next paper, we will provide measurements by fitting these lines to find velocity centroids and equivalent width measurements. Once we have these values, we will examine each individual spectrum for variability in equivalent width, velocity, and/or new components, which could lead to transverse velocities for the absorbers as seen in Kraemer et al. (2001).

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APPENDIX A

NOTES ON INDIVIDUAL OBJECTS WITH INTRINSIC ABSORPTION

A1. QSO 0045+3926

QSO 0045+3926 is a new intrinsic-absorption discovery. We find that this object shows clear single-line absorption in all three lines. The O vi region is found in the SiC portion of the spectrum; while the signal is lessened, there are no ISM lines nor any H2 contamination.

A2. TON S180

Ton S180 shows very weak absorption, with some contamination from H2 and a N ii ISM line in the Lyβ line and no sign of H2 absorption in the O vi red member. The Fe ii ISM appears to be negligible based on the essentially nonvisible nearby lines. This object was first seen as an absorber in Kriss (2002) but no intrinsic absorption was detected longward of 1200 Å.

A3. MRK 1044

Fields et al. (2005) have identified the same lines we found in the FUSE observation. The obvious component appears in both the O vi lines, but the Lyβ line is seriously contaminated via H2. There is also evidence for a weaker line that appears to be slightly blended with Ar i in the O vi blue member, but is not clearly visible in O vi red and nonexistent in Lyβ.

A4. NGC 985

Absorption for this target was seen by Kriss (2002). Kriss lists this target with only one component, while we find that there are three narrow-line absorbers with one blended broad absorber, which may consist of two subcomponents. The H2 spectrum is varied in each of the O vi and Lyβ lines, allowing for clear identification of each of these lines.

A5. EUVE J0349−537

EUVE J0349−537 was first found in the EUVE survey, and the optical counterpart was found by Craig & Fruscione (1997). Since that time it has appeared in four more surveys, but no exorbitant amount of study has been placed on it. This target shows one absorber that is broad enough that it is clearly above the noise, with a second nearby absorption feature that could be noise as it is only slightly visible in the O vi lines. This is a new absorption detection.

A6. IRAS F04250−5718

This object originated in the Einstein Slew Survey (Elvis et al. 1992). We find at least two components absorbing in the far ultraviolet. It shows a broad component blended with a narrower component at a slightly lower velocity with very little contamination. This absorption has been seen previously by Kraemer et al. (1999).

A7. MRK 79

We see one component that is broad and shows very little contamination in the O vi lines. The Lyβ line is significantly weaker but still visible with little contamination. The second component is a narrow feature that is visible in the O vi red member, while the blue is highly contaminated and the Lyβ absorption is weak at best. This absorption has been identified previously (Kraemer et al. 1999).

A8. MRK 10

This object shows H2 interference in both of the O vi doublet lines and Ar i (1067) in the O vi red member. The absorption features are much too broad for H2 and ISM absorption to completely explain them. Thus, we find one or possibly two broad blending components. Mrk 10 has not been identified before as an intrinsically absorbing object.

A9. IR 07546+3928

This object was found in the New Bologna Sky Survey (Ficarra et al. 1985); it has been flagged for possible C iv absorption studies with the International Ultraviolet Explorer (IUE; Lanzetta et al. 1993). However, it has not been labeled as an intrinsic absorbing target until now. In the FUSE observations there are two broad components that are heavily contaminated in the O vi blue member by Fe ii ISM lines. The Lyβ and the O vi red member are fairly devoid of contamination.

A10. PG 0804+761

While the spectrum of this object shows dayglow N i, the intrinsic absorption lines are evident with no clear interference from ISM. This object is a newly found intrinsic absorber.

A11. TON 951

Ton 951 was identified by Kriss (2002) in his conference paper. We find a single narrow absorption feature. Only one of the three available lines has any H2 contamination.

A12. IRAS 09149−62

One of the less well studied AGN targets, IRAS 09149−62 shows broad absorption features across both members of the O vi doublet. The N ii dayglow lines leave whether or not Lyβ shows absorption to speculation. This detection is a first for this object.

A13. MRK 141

This spectrum is highly noisy, and the continuum flux level is extremely low. There are two lines that are in the same place in velocity space from O vi, but this object is not an ideal example of an intrinsic absorber due to the lack of a Lyβ line at that velocity. It was classified as an intrinsic absorber by Kriss (2002).

A14. NGC 3516

We present in this paper two new observations of NGC 3516 taken by FUSE. There have been a total of six observations taken with FUSE. In the first observation Kriss (2002) identified the same components seen in FOS, STIS, and GHRSS data by Crenshaw et al. (1999) and Kraemer et al. (2001). Kraemer et al. showed that NGC 3516 shows variability in the absorption features, allowing them to find a lower limit on the transverse velocity of ∼1800 km s−1.

A15. ESO 265-G23

This spectrum is full of H2 features; however, there is at least one absorption feature and two more possible components. The Lyβ for the second possible component has a strong N ii ISM line in it, while the O vi red member is aligned with a Fe ii ISM line. This is a new intrinsic UV absorption discovery.
NGC 3783 was heavily studied by Gabel et al. (2005) using STIS and FUSE spectra. We find two broad components covering the span between \(-500\) and \(-800\) km s\(^{-1}\), which agrees with Gabel et al. (2005). However, Gabel et al. found a component at \(-1350\) km s\(^{-1}\) that is coincident with a feature in Ly\(\beta\); the O \(\text{v}\) lines are somewhat less convincing in the FUSE spectrum.

NGC 4051 shows a broad absorbing region that has no real contamination in the O \(\text{v}\) blue member. The O \(\text{v}\) red member is visible, but an O \(\text{i}\) dayglow line lies inside the trough, and the Ly\(\beta\) has a similar problem, with an O \(\text{i}\) dayglow line alongside the Ly\(\beta\) dayglow line. Using STIS, Collinge et al. (2001) found two absorbing systems, one at approximately \(-600\) km s\(^{-1}\) and one at approximately \(-2400\) km s\(^{-1}\). Each of these broad components break into up to eight smaller components in STIS spectra in the C \(\text{iv}\) and N \(\text{v}\) lines. In the FUSE data we see only the lower velocity component. There is no evidence in the FUSE spectrum for a higher velocity component.

Kraemer et al. (2006 and references therein) performed an in-depth study on NGC 4151, which showed multiple components in STIS spectra. In the FUSE data we find multiple components blended together due to the sensitivity of O \(\text{v}\) to intrinsic absorption. The Ly\(\beta\) region is spoiled by the Ly\(\beta\) dayglow. We only provide the centroid of the velocity in Table 2 for this object.

Due to the high redshift of RX J1230.8+0115, there is little interference from the ISM (only three Fe \(\text{ii}\) lines). There appears to be at least one broad component with two other unexplained lines (1051 and 1050 \(\AA\)) with two other broad absorption regions that do not have corresponding matches in velocity space. This was recognized by Ganguly et al. (2001) and attributed to intervening gas in the IGM.

This object has been classified as a Seyfert 2 galaxy (NED), but there does seem to be evidence for a broad-line region in the FUSE spectrum. We find one broad component that shows some contamination from H\(_2\), Ar \(\text{i}\), and C \(\text{i}\). Because this has been labeled as a Seyfert 2 galaxy, it seems this object has not been considered as a target for intrinsic absorption studies.

PG 1351+640 has ample ISM contamination, but the overall absorption features look to be the same in all three lines. This was seen by Kriss (2002) and fitted by Zheng et al. (2001).

seen by Kriss (2002) and followed up with further study and Chandra X-Ray Observatory observations by Scott et al. (2004), we find that there are three possible components. Of the three only one is free from question of contamination. The other two could be combinations of H\(_2\) or ISM lines; however, there seems to be a paucity of H\(_2\) absorption in nearby regions of the spectrum. Two of the three features appear to be intrinsic absorption.

This spectrum is in a very low continuum flux state, but shows evidence for one component of absorption with no contamination. This is a new intrinsic UV absorption discovery.

While the spectrum shows heavy ISM contamination, there are three absorption components uncorrupted in the O \(\text{v}\) red member. These components agree in velocity with their O \(\text{v}\) blue member and Ly\(\beta\) counterparts and have very little overlap with the ISM lines. This was a common target with the Laor & Brandt (2002) survey.

Laor & Brandt (2002) found that PG 1411+442 showed a large range of velocity for the intrinsic absorption (~5000 km s\(^{-1}\)). Unfortunately, with the redshift for this object, the O \(\text{v}\) region falls into the SiC portion of the spectrograph and provides less signal. We do not have enough signal to see the broad absorption Laor & Brandt found, but we have found two narrow components that are quite clear.

NGC 5548 was found to be intrinsically absorbing by Shull & Sachs (1993) in data from IUE along with evidence of X-ray warm absorption (George et al. 1998). Crenshaw et al. (1999) found absorption in FOS data as well. More recently Crenshaw et al. (2003) saw five blended and broad components in data from STIS. We see a case similar to what Crenshaw et al. did in the FUSE data, with five blended and broad components.

We consider this a weak absorber. Mrk 817 shows a weak absorption line that is isolated in the O \(\text{v}\) blue member and has a weak Fe \(\text{ii}\) contaminate in the O \(\text{v}\) red member. The Ly\(\beta\) is hardly visible, but this is easily understood due to the lower sensitivity of Ly\(\beta\). This object has the fastest radial velocity component in a Seyfert galaxy to date (Table 2), as seen in Kriss (2002).

Mrk 509 shows absorption broad enough that it was first seen in data from IUE by York et al. (1984). It also shows evidence for an X-ray warm absorber, as discussed in Reynolds (1997) and George et al. (1998). Kriss (2002) published the FUSE spectrum and identified the absorption components.

Kraemer et al. (2003) examined STIS data and found eight components spanning the velocity range between \(-422\) and \(+210\) km s\(^{-1}\). They performed photoionization modeling of the
absorbers and found that they are not the same absorbing regions as the X-ray absorbers. In the FUSE observations with high resolution, we see in the Lyβ absorption feature the same two broad absorbers. However, due to the fact that the Lyβ line is less sensitive, we can see that the two broad components are between four and five components, the fifth overlapping with a coincident H₂ line.

A31. II Zw 136

Crenshaw et al. (1999) found two components in the FOS spectra for II Zw 136, which we see repeated in our FUSE observations. Component 1 is clearly visible and virtually free of ISM interference; component 2, however, in the FUSE observations is clearly seen only in the O vi red member. Lyβ is weak at best, and the O vi blue member is heavily contaminated with an Fe ii line and two H₂ lines in the vicinity.

A32. ARK 564

Ark 564 shows two broad and blended absorption components. H₂ lines heavily populate the area but are far too narrow to account for the absorption. Crenshaw et al. (1999) saw absorption in the FOS data at the same central velocities we find. Romano et al. (2002) published the FUSE spectrum for this target and also identified the same components we find. Crenshaw & Kraemer (2001) found that this was one of two Seyfert galaxies that showed traits they characterized as indicative of a dusty lukewarm absorber.

A33. IRAS F22456–5125

This object was seen first in the ROSAT wide-field survey and later observed in the EUV. X-ray studies have found this target to be highly variable (Grupe et al. 2001), but no ultraviolet intrinsic absorption has been previously identified. In our spectra we find five “finger-like” narrow absorption components with little to no contamination from the ISM.

A34. MR 2251–178

Ganguly et al. (2001), using FOS and STIS observations, found variability in the absorption in both velocity and column density. They found that the velocity of the component was ~1300 km s⁻¹, in data from STIS and FOS. We find that this object shows clear absorption in both Lyβ and the O vi red member. While the blue member has both H₂ and ISM contamination, the velocity overlap is adequate enough to say that a significant portion of the absorption feature is intrinsic to the object. The question for MR 2251–178 is whether the absorption is best aligned at ~2000 km s⁻¹ where the Lyβ absorption is weak and possibly just ISM contamination, or at ~300 km s⁻¹ where the O vi red member is weak. This could be a case of coincidental alignment, where there are absorbers at both of these velocities; thus, two of the features will be broader than the third component. Because X-ray studies have shown this to be highly variable in X-ray absorption (Halpern 1984) and variable in the UV (Ganguly et al. 2001) it seems likely that the velocity of the component has shifted, either accelerating to ~2000 km s⁻¹ or decelerating to ~300 km s⁻¹.

A35. NGC 7469

NGC 7469 is a highly studied Seyfert 1 galaxy. Many surveys and studies to date have classified this as an intrinsically absorbing Seyfert galaxy (Scott et al. 2005; Kriss 2002; Crenshaw et al. 1999). Thus, this object is a known intrinsic absorber. In the FUSE data, however, the absorption appears very weakly, and in the Lyβ line there is a C ii ISM line along with two heavy H₂ lines leaving doubt about the absorption feature. The O vi blue line is found at the same wavelength as Ar i (λ1048 Å), which tends to be a strong ISM line in the far-UV.

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