PHYSICAL CONDITIONS IN THE ULTRAVIOLET ABSORBERS OF IRAS F22456−5125*

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ABSTRACT

We present the ultraviolet (UV) and X-ray spectra observed with the Far Ultraviolet Spectroscopic Explorer (FUSE) and the XMM-Newton satellite, respectively, of the low-z Seyfert 1 galaxy IRAS F22456−5125. This object shows absorption from five distinct, narrow kinematic components that span a significant range in velocity (~0 to ~700 km s$^{-1}$) and ionization (Lyman series, C iv, N iii, and O vi). We also show that three of the five kinematic components in these lines appear to be saturated in Lyβ λ1026 and that all five components show evidence of saturation in the O vi doublet lines λλ1032, 1038. Further, all five components show evidence for partial covering due to the absorption seen in the O vi doublet. This object is peculiar because it shows no evidence for corresponding X-ray absorption to the UV absorption in the X-ray spectrum, which violates the 1:1 correlation known for low-z active galactic nuclei (AGNs). We perform photoionization modeling of the UV absorption lines and predict that the O vi column density should be small, which would produce little to no absorption in agreement with the X-ray observation. We also examine the UV variability of the continuum flux for this object (an increase of a factor of 6). As the absorption components lack variability, we find a lower limit of ~20 kpc for the distance from the absorbers from the central AGN.

Key words: galaxies: Seyfert – ultraviolet: galaxies

1. INTRODUCTION

It has become well known that most massive galaxies host a supermassive black hole in their core (e.g., Kormendy & Richstone 1995; Gebhardt et al. 2003). Active galactic nuclei (AGNs) are galaxies where the black hole is surrounded by an accretion disk, which provides immense luminosity. Seyfert galaxies are moderate-luminosity AGNs ($L_{\text{Bol}} \approx 43–45$ erg s$^{-1}$) that were first classified by Seyfert (1943), and were later divided into two categories (Seyfert 1 and Seyfert 2) by Khachikian & Weedman (1974) based on spectroscopic observations of their emission lines. Seyfert 1 galaxies contain broad emission lines (BELs; FWHM ≈ 1000–5000 km s$^{-1}$) of permitted transitions covering a large range in ionization. By contrast, Seyfert 2 galaxies only exhibit narrow emission lines (NEL; FWHM ≈ 500–800 km s$^{-1}$), which arise from both forbidden and permitted transitions. This was later explained in a unified model (Antonucci & Miller 1985; Urry & Padovani 1995), where a putative torus obscures the BEL region in Seyfert 2 galaxies.

It is found in many cases that the BELs of Seyfert 1 galaxies observed in the ultraviolet (UV) have blueshifted absorption features that are associated with outflowing gas from the AGN. Crenshaw et al. (1999) showed in a survey of Seyfert galaxies, using data from the Faint Object Spectrograph (FOS) and Goddard High Resolution Spectrograph (GHR) on the Hubble Space Telescope (HST), that UV absorbers in C iv λλ1048, 1551 are relatively common (~60%). Another survey by Dunn et al. (2007) of Far Ultraviolet Spectroscopic Explorer (FUSE) archival data showed that these outflows are also common in the O vi doublet 1032, 1038 and Lyβ λ1026 lines (~50%) with a global covering factor ($C_{\text{ly}}$) ≈ 0.4 and that the O vi absorption features frequently vary (~40% of the objects) in low-z AGNs.

In our survey, we discovered the intrinsic UV absorption lines in the Seyfert 1 galaxy IRAS F22456−5125 (RE J2248−511, z = 0.1016 ± 0.0001). The luminosity of this object is log $L_{\text{Bol}}$ (erg s$^{-1}$) = 45.53 (Dunn et al. 2008). Given the redshift and luminosity of this object, it could be considered a low-z quasar. However, the spectrum of IRAS F22456−5125 is more similar to that of Seyfert 1 galaxies with strong narrow emission lines. We also found that this object was unique amongst the other objects with O vi absorption as it showed five relatively narrow and separable absorption features, as opposed to blended and saturated absorption troughs found in other objects, situated in a velocity range that spans 700 km s$^{-1}$. Due to its singular nature, we selected this object to evaluate in more detail.

Currently, there are several UV observations of IRAS F22456−5125. In the UV, the International Ultraviolet Explorer (IUE) observed this object five times and FUSE observed it three times. The continuum flux history of IRAS F22456−5125 is given by the IUE data, as shown by the online AGN Light Curve Database, which shows that IRAS F22456−5125 was in a low-flux state during the observations taken with FUSE. In the optical regime we have obtained two spectra from CTIO (published in Dunn et al. 2008) and two spectroscopic observations were taken with 2.2 m and 2.1 m telescopes at La Silla, Chile, and McDonald Observatory of the University of Texas at Austin, respectively (Mason et al. 1995; Grupe et al. 1998). These spectra were published in a figure later in Breeveld et al. (2001) and appeared to show that the continuum slope varied drastically over the span of a year.

IRAS F22456−5125 has also been observed several times in the extreme UV and X-ray regimes. It was first detected in a ROSAT observation by Pounds et al. (1993). They noted that this object belongs to uncommon type of Seyfert galaxies with a steep spectral component at energies <1 keV. It was later observed by the Advanced Satellite for Cosmology and
Astrophysics (ASCA). Both the ROSAT and ASCA data points are published by Breeveld et al. (2001). Finally, IRAS F552456−5125 has three previously unpublished XMM-Newton observations.

We begin in Section 2 with an analysis of the X-ray observations and discuss the shape of the ionizing spectral energy distribution (SED). In Section 3, we examine the individual FUSE spectra and measure several parameters (e.g., ionic column densities). Section 4 provides a brief look at the time variability of the system, and in Section 5 we outline our conclusions.

2. X-RAY ANALYSIS

Breeveld et al. (2001) approximated the SED from the available observations in the X-ray, UV, and optical. They noted that IRAS F22456−5125 showed two interesting features. The first was that the X-ray observations showed evidence for an ultrasoft X-ray excess, and the second was that the optical spectra drastically changed slopes over the span of a year. Their power-law fits ($F_\nu \propto \nu^\alpha$) for the X-ray were $\alpha = -1.3$ and $\alpha = -0.8$ for the soft (0.3–2 keV) and hard X-ray (2–10 keV), respectively, and a very high value of $\alpha = -3.1$ for the ultrasoft X-ray excess (0.1–0.3 keV). They claim that this excess, however, appears to be variable over time along with the slope in the optical regime. The optical slopes vary between $\alpha = -1.3$ in the 1992 observation from Grupe et al. (1998) and $\alpha = +0.8$ in the 1991 observation from Mason et al. (1995).

In order to better evaluate the X-ray spectrum of IRAS F22456−5125, we have retrieved the archived XMM-Newton X-ray observations taken with the European Photon Imaging Camera (EPIC) pn detector. The observation (ID 0510380101) was taken over the dates of 2007 May 15 and 16 at 10:37, with an exposure time of 4.506 ks. We reduce the data using the standard EPCHAIN processing script included in version 7.1.0 of the XMM-Newton Science Analysis System (XMMSAS) software. The data were filtered to exclude non-X-ray events; only events with event patterns in the range 0–4 (single and double pixel events) were kept. The source spectrum was extracted from a 32″-radius circle, the size of the X-ray point source on the PN chip. The background spectrum was extracted from another 32″ circle on the same chip as the source, but from an area free of any background sources. We generate response matrices and ancillary response matrices using the XMMSAS tasks rmfgen and arfgen. The resulting background-subtracted spectrum is shown in Figure 1. The XMM-Newton spectrum of IRAS 22456−5125 is well fit ($\chi^2 = 1234.94$ for 953 degrees of freedom) by a power law with photon index $\Gamma = 1.77$ and a soft excess below 1 keV (modeled simplistically in our spectrum with a Gaussian).

We examine and find no evidence for an X-ray warm absorption edge in these data, as shown in Figure 2. The lack of absorption, combined with the power laws prescribed by Breeveld et al. (2001), leads us to believe that IRAS F22456−5125 is devoid of strong X-ray absorbers. These XMM-Newton data were taken approximately two years after the data from FUSE and when combined with the Breeveld et al. study show that the soft X-ray excess has existed for several years. A consequence of this long-standing X-ray excess, which spans a range that includes the FUSE observations, is that the lack of corresponding X-ray absorption must be due to a paucity of X-ray absorbing gas in the cloud.

The “soft excess” also gives information about the AGN itself. Frequently, low-$z$ AGNs (e.g., Reeves & Turner 2000; Piconcelli et al. 2005) show a soft X-ray excess and it has been shown that the soft X-ray spectral slope presence is more common in high Eddington ratio ($L/L_{edd} \approx 1$; Grupe 2004; Czerny et al. 2003) objects such as narrow-line Seyfert 1 galaxies (NLS1). However, despite this excess, Dunn et al. (2008) have shown with optical spectra that IRAS F22456−5125 is not a high accretion rate object with an Eddington ratio of only $L/L_{edd} \approx 0.16$ and furthermore showed that IRAS F22456−5125 is not an NLS1 galaxy (i.e., FWHM(Hβ) ≈ 3300 km s$^{-1}$).

3. FUV ANALYSIS

We obtained the archived FUSE spectra from the Multimission Archive at Space Telescope (MAST) presented in Table 1. We processed these data with the CalFUSE reduction package (v3.2) in time-tag mode (TTAG; Dixon et al. 2002, see Dunn et al. 2007 for full details). The output data consist of 8 spectra per observation for each grating and detector, which we weighted by exposure time per segment of the detector, and then
Table 1

<table>
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<th>Date</th>
<th>Julian Date</th>
<th>Observation ID</th>
<th>Exposure Time (s)</th>
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</tbody>
</table>

Note. * Julian date +2400000 days.

**Table 2**

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<tr>
<th>Comp</th>
<th>Velocity (km s$^{-1}$)</th>
<th>FWHM (km s$^{-1}$)</th>
<th>$C_f$ (Ly$\beta$)</th>
<th>$C_f$ (O vi)</th>
<th>1−$I_r$ (Ly$\beta$)</th>
<th>$\sigma_f$</th>
<th>1−$I_r$ (O vi)</th>
<th>$\sigma_f$</th>
</tr>
</thead>
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<td>0.13</td>
<td>0.69</td>
<td>0.11</td>
</tr>
<tr>
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<td>$-608$</td>
<td>112</td>
<td>0.84</td>
<td>0.69</td>
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<td>0.13</td>
<td>0.64</td>
<td>0.11</td>
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<tr>
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<td>0.10</td>
</tr>
<tr>
<td>4</td>
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<td>0.70</td>
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<td>0.12</td>
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</tr>
<tr>
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<td>$-130$</td>
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<td>0.95</td>
<td>1.00</td>
<td>0.12</td>
<td>0.95</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Note. * Used apparent optical depth for the column density limit.

co-added across the segments and scaled to match the flux in the segment that was used for primary alignment of the object (the LiF 1a segment). We show the full FUSE spectrum in Figure 2.

As we have stated, IRAS F22456−5125 shows an interesting assortment of intrinsic absorption lines in the FUV. Currently, there are no observations of IRAS F22456−5125 with sufficient resolution to examine the C iv, N v, and Si iv doublets for absorption. The five kinematic components detected in the FUSE data span a velocity range of 700 km s$^{-1}$, which we number from highest velocity to lowest 1−5 (see Table 2). Three of these five components (2, 3, and 5) are strong in Ly$\beta$, Ly$\gamma$, and C iv doublet, respectively (O VI) (Ly$\beta$). We present these LOS covering factor solutions in Table 2.

To calculate the LOS covering factor of the Lyman lines (as covering factor is not necessarily the same from ion to ion), we utilize Ly$\beta$ and Ly$\gamma$. These are not a doublet, and Equation (2) cannot be used to solve for the LOS covering. Instead, we can calculate the LOS covering and optical depth by simultaneously solving a system of equations for normalized intensity of two troughs with partial LOS covering:

$$I = 1 - C_f + C_f e^{-r\tau},$$

where $I$ is the normalized intensity and $r$ is the ratio of oscillator strengths and wavelengths ($\sim 2.08$ for the ratio of Ly$\beta$ to Ly$\gamma$). Thus, we use the maximum trough depths to determine the LOS covering factor.

Because components 2, 3, and 5 are saturated, $\tau$ approaches infinity for Ly$\beta$. Thus, we do not include Ly$\beta$ for the calculation of the H i column density in these components. Ly$\gamma$ shows the same trait for component 3. Components 2 and 5, however, are measurable in Ly$\gamma$ and Ly$\delta$, while Ly$\delta$ and Ly$\eta$ provided good estimates for component 3. For each component, we find at least two lines, for consistency, that are measurable and allow us to calculate an H i column density, shown in Table 3.

The troughs for component 2 are contaminated in both O vi doublet lines. We see that an Fe ii interstellar medium (ISM) line is blended with O vi $\lambda 1032$. The O vi $\lambda 1038$ component
through Equations (3) and (4) to find the error in column density. We propagate the dominant source of the error (the error in flux) to \( N \). The deviation of multiple lines of the same ion. This does not apply in Table 3. Our error estimates are derived from the standard deviation on them. Furthermore, there is an \( \lambda 1084 \) ISM line that lies at the same wavelength of component 2 in \( \lambda 1084 \) ISM line. The logs of the elemental abundances, relative to H by number, are as follows: He: \( \lambda 13.92, O: \lambda 13.17, Ne: \lambda 13.53, Si: \lambda 13.64, P: \lambda 13.63, S: \lambda 13.40, Ca: \lambda 13.56, Fe: \lambda 13.40, and Ni: \lambda 13.75. Because the predicted ionic column densities are not sensitive to density for \( n_H < 10^{11} \) cm\(^{-2}\), and we have no solid constraints on the radial distances of the absorbers, we assumed \( n_H = 10^5 \) cm\(^{-3}\).

We base our model intrinsic SED on the 1020 Å flux observed with \( \text{FUSE} \) and the X-ray fluxes from Breeveld et al. (2001), as detailed in Section 2. We assume a broken power law of the form \( L_\nu \propto \nu^\alpha \) as follows: \( \alpha = -0.77 \) for energies \( <12.15 \) eV, \( \alpha = -1.3 \) over the range \( 12.15 \) eV \( \leq \nu < 0.3 \) keV, \( \alpha = -1.6 \) for \( 0.3 \) keV \( \leq \nu < 2 \) keV, and \( \alpha = -0.8 \) for \( \nu > 2 \) keV. We included a low energy cutoff at 1 eV and a high energy cutoff at 100 keV. The resulting luminosity in ionizing photons is \( Q = 2 \times 10^{55} \) photons s\(^{-1}\).

The model results are shown in Table 4. The models are deemed to have successfully fit the data when the predicted \( H \) and either the \( C \) or the \( O \) columns are within one sigma of their measured values. For components 2, 3, and 5, the model over-predicts \( O \), while fitting the \( H \) and \( C \), which suggests that the \( O \) is saturated. The one discrepancy for these components is the under-prediction of the \( C \) in component 2. To rectify this would require an N/C abundance ratio a factor ~12 times greater than solar, which seems highly unlikely. The more likely scenario is that the column is due to

\[ U = 4 \pi r^2 n_H, \text{ where } r \text{ is the radial distance of the absorber and } Q = \int_{1.0}^{\infty} \frac{L_\nu}{h \nu} d\nu, \text{ or the number of ionizing photons } s^{-1} \text{ emitted by a source of luminosity } L_\nu. \]

### 4. PHOTIONIZATION MODELS

The photoionization models used for this study are generated using the 07.02.01 version of Cloudy (Ferland et al. 1998). The models are characterized by an ionization parameter, \( U \), and hydrogen column density, \( N_H = N_{H^+} + N_{H^{-}} \) (in units of cm\(^{-2}\)). We assume roughly solar elemental abundances (e.g., Grevesse & Anders 1989) and that the absorbing gas is free of cosmic dust. The logs of the elemental abundances, relative to H by number, are as follows: He: \( \lambda 13.92, C: \lambda 13.47, N: \lambda 13.92, O: \lambda 13.17, Ne: \lambda 13.53, Si: \lambda 13.64, P: \lambda 13.63, S: \lambda 13.40, Ca: \lambda 13.56, Fe: \lambda 13.40, and Ni: \lambda 13.75. Because the predicted ionic column densities are not sensitive to density for \( n_H < 10^{11} \) cm\(^{-2}\), and we have no solid constraints on the radial distances of the absorbers, we assumed \( n_H = 10^5 \) cm\(^{-3}\).

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2 trough has an unidentified trough partially blended with the outflow kinematic component. Both of these can be seen in Figure 3. We attempt to exclude these features and measure only the absorption line related to the outflow. We provide the estimates of column densities for \( O \), \( C \), \( N \), and \( H \) in Table 3. Our error estimates are derived from the standard deviation of multiple lines of the same ion. This does not apply to \( C \) as there is only one line for measurement. Therefore, we propagate the dominant source of the error (the error in flux) through Equations (3) and (4) to find the error in column density for components 2, 3, and 5 for which we have measurements. With the exception of component 2, the \( N \) lines are only one limit on them. Furthermore, there is an \( \lambda 1084 \) ISM line that lies at the same wavelength of component 2 in \( N \) which leads to an overestimate for the column density. Components 2, 3, and 5 are only lower limit measurements for \( O \), because as we have shown \( 1 - I_r \) is very close to the estimated covering factor, and we therefore assume that the lines are saturated.

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the N\textsc{ii} ISM contamination in the spectrum. In components 1 and 4, we are able to match the H\textsc{i} and O\textsc{vi} columns, indicating that the latter are not saturated. The C\textsc{iii} is over-predicted in the component 1 by a factor of ~2.5. It is possible that some of the carbon is deposited onto dust grains; there would be no detectable extinction through a cloud with such a low column density, so it is possible that dust is present.

Although Seyferts with intrinsic absorption nearly always possess both UV and X-ray absorption (Crenshaw et al. 2003), the fact that all five components have O\textsc{vi} column densities <3x 10^{16}\text{ cm}^{-2} (Table 5) is consistent with the lack of detectable X-ray absorption in both the ASCA and XMM-Newton spectra of IRAS F22456—5125.

5. DISTANCE AND DENSITY ESTIMATES

Assuming that the clouds do remain unchanged between the FUSE observations, which is consistent with these data given the S/N, we can estimate a lower limit to the distance for these clouds based on the ionization timescale given the increase in flux. If we consider the ionization timescale to be (Krolik & Kriss 1997)

\[ t_{\text{ion}} = \frac{h\nu}{F_{\text{ion}}(\sigma_{\text{ion}})} = \frac{h\nu 4\pi R^2}{L_{\text{ion}}(\sigma_{\text{ion}})} \tag{5} \]

where \(\langle \sigma \rangle_{\text{ion}} \approx 6 \times 10^{-18}\text{ cm}^2\) (Osterbrock 1989), \(F_{\text{ion}}\) and \(L_{\text{ion}}\) are the ionizing flux and luminosity, respectively, and \(h\nu\) is the ionization energy of hydrogen. We calculate an ionizing luminosity from the SED fits from Breeveld et al. (2001) and use the difference in time between the FUSE observations (\(\Delta t = 5.6 \times 10^7\text{ s}\)) as a lower limit of the ionization timescale \(t_{\text{ion}}\) to determine a lower limit to the distance \(R\). For IRAS F22456—5125, the ionizing luminosity, based on the slopes determined by Breeveld et al. (2001), is 3.0 \times 10^{45}\text{ erg s}^{-1}. This gives a distance greater than 20 kpc from the central engine.

As we have already demonstrated, several of these components are saturated (i.e., 2, 3, and 5) in O\textsc{vi} and Ly\beta. Given that these lines are saturated, we do not expect the observed O\textsc{vi} and Ly\beta lines to vary even with substantial changes in column density due to ionization. It is consistent with the large distances, however, that these components do not appear to vary in the higher order Lyman lines, which do not appear to be saturated. The other two components (1 and 4) do not appear to be saturated in Ly\beta. Thus, we establish the limits on distance for 1 and 4 from Ly\beta, and from the higher order Lyman series for the other three components.

Considering these limits on distance, we can calculate the upper limit of the density for the absorbers via the ionization parameter. For each of the components, we use the equation for ionization parameter and the values from Table 3 to find that the upper limits for the densities are 0.2, 0.3, 0.3, 0.5, and 0.2 cm\(^{-3}\) for components 1 through 5, respectively.

The distances for several Seyfert galaxy and low-z quasar outflows have been shown to be quite close in, which leads to a more plausible scenario for partial covering of the background source, or an inhomogeneous distribution across the LOS. It is more difficult to explain an absorption cloud located at a large distance from the central source (e.g., >1 kpc) with partial covering. While this is difficult, it appears that it is common in outflows as distances of kpc scales for outflows have been seen in several objects thus far. Measurements of excited, metastable state transition lines in broad absorption line (BAL) quasars have shown that several outflows lie at large distances, from 1 kpc to 28 kpc (e.g., Korista et al. 2008; Hamann et al. 2001). In only one of these objects has homogeneous covering been detected (i.e., full covering; Dunn et al. 2010). IRAS F22456—5125 is another object with outflows that likely are located at large distances yet shows partial covering. This could mean that in many AGNs there exists a scattering region significantly larger than the BLR that acts as a background source, which has been supported by spectropolarimetry (e.g., Schmidt & Hines 1999). Another more physical possibility, given the large distances, is that these outflows are not purely covering a part of the source but that there exists some inhomogeneous distribution of gas across the LOS to the background source that approximates partial covering, as demonstrated by Arav et al. (2005).

6. SUMMARY AND CONCLUSIONS

We selected IRAS F22456—5125 out of our sample for further analysis due to its uniqueness. This Seyfert 1 galaxy is a rare object because it shows five distinct narrow lines in O\textsc{vi}, whereas most intrinsic absorbers in O\textsc{vi} are blended and saturated compared to C\textsc{iv} and N\textsc{v}. This allows for measurements of the ionic column densities without contamination from blending.

1. We limit the distance for two of the components from variability to be greater than 20 kpc, which likely places this gas in the host galaxy’s halo. The other three components are limited in the same fashion, however, due to possible saturation could be interior.

\begin{table}[h]
\centering
\caption{CLOUDY Model Parameters and Results\textsuperscript{a}}
\begin{tabular}{cccccc}
\hline
Component & \(\log N_{\text{H}}\) & \(\log U_{\text{H}}\) & H\textsuperscript{\beta} & O\textsuperscript{vi} & C\textsuperscript{\textit{m}}\textsuperscript{b} & N\textsuperscript{i}\textsuperscript{\beta}\textsuperscript{b} \\
\hline
1 & 18.6 & 2.3 & 8.8 (8.9) & 0.07 (<0.03) & 0.01 (<0.2) & \\
2 & 19.7 & 1.3 & 44.3 (44.1) & 110 (>8.8) & 1.8 (1.8) & 0.40 (<6.4) \\
3 & 19.7 & 1.3 & 40.9 (42.3) & 112 (>8.7) & 1.6 (1.3) & 0.33 (<0.6) \\
4 & 18.5 & 1.3 & 5.5 (5.5) & 5.3 (5.2) & 0.35 (<0.5) & 0.10 (<0.1) \\
5 & 20.1 & 1.0 & 59.3 (60.1) & 288 (>14.2) & 1.4 (1.3) & 0.21 (<0.6) \\
\hline
\end{tabular}
\end{table}

Notes.
\textsuperscript{a} Ionic column densities are given in units of \(\times 10^{14}\text{ cm}^{-2}\).
\textsuperscript{b} Observed values are given in parentheses.

\begin{table}[h]
\centering
\caption{O\textsc{vi} Predictions}
\begin{tabular}{ccc}
\hline
Component & \(N_{\text{O\textsc{vi}}}\) \(\times 10^{19}\text{ cm}^{-2}\) \\
\hline
1 & 8.8 \\
2 & 72 \\
3 & 39 \\
4 & 1.9 \\
5 & 361 \\
\hline
\end{tabular}
\end{table}
2. We have shown that, despite the large distances, this gas only partially covers the background source, which is consistent with other absorption systems seen in the literature.

3. Crenshaw et al. (1999) found a 1:1 correlation between UV absorption detection and X-ray warm absorbers in low-z AGNs. We see in the ultrasoft X-ray excess seen by Breeveld et al. (2001) and the excess we find in the XMM-Newton spectrum that there are no signs of X-ray absorption. Furthermore, based on our measurements and Cloudy modeling, we find little evidence for the commonly detected strong O vii X-ray absorption. The lack of X-ray absorption makes IRAS F22456−5125 an exception to the correlation.

4. We note that the SED for IRAS F22456−5125 may have varied as shown by Breeveld et al. (2001). However, in our observations from 2007, we show that the slope is similar to the 1991 observation, with a positively increasing slope to the blue.

As outlined by Hamann et al. (1997), because these outflows exhibit partial covering of the background source they are intrinsically connected with the AGN. However, given the lack of change in the absorption troughs, we must consider that these outflows are located at a large distance from the AGN (on the order of 20 kpc) and are perhaps not traditional outflows that originated near the accretion disk. The lack of X-ray absorption in this source, unlike all other low-z AGNs, could be a further indication that the outflows are atypical in origin.

However, we cannot rule out that the lack of change in the lines is due to the low S/N in the FUSE spectrum. With a higher S/N spectra from a high-throughput instrument, such as the Cosmic Origins Spectrograph (COS) on the HST, we could confirm the lack of variability and thus more reliably discuss the nature of the outflow.

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