Abstract

With an order-of-magnitude increase in sensitivity over previous far-ultraviolet (FUV) spectrographs, the Cosmic Origins Spectrograph (COS) onboard the Hubble Space Telescope (HST) has observed hundreds of active galactic nuclei (AGN) over a wide range of luminosities and spectral types in the z=2 universe. Observing FUV wavelengths (1130-1800 Å) gives COS access to many AGN accretion disk and broad emission-line region (BELR) diagnostics, such as ionizing power-law continua and strong FUV and extreme-ultraviolet (EUV) emission lines. These features are especially accessible in spectra of AGN at low-redshifts due to minimal contamination by Lyα forest absorption. Using the growing number of archival COS AGN spectra (N=150) we present composite FUV/FUV AGN spectra and derive spectral indices for the power-law continua of individual objects and redshift sub-sample composite spectra. We investigate correlations between spectral index, luminosity, redshift, and spectral type. We discuss our results in the context of a two-component wind+disk model of the BELR.

Fits to Individual Spectra

Low-Redshift Example

Figure 1: Dereddened flux (black) of M81 plotted in the AGN's rest-frame over-plotted with a spline fit (green). The blue line is the power-law fit to the continuum with the orange circles indicating the fitted points.

High-Redshift Example

Figure 2: Dereddened flux (black) of SDSS J100535.24+013445.7 plotted in the AGN's rest-frame over-plotted with a spline fit (green). The red line shows the flux after two partial LLSs were modeled and corrected. The purple line is the correct spline fit. The placement of each LLS is marked with a vertical dashed line and includes the LLS's redshift. The blue line is the power-law fit to the continuum with the orange circles indicating the fitted points.

Figure 3: This is an enlarged plot of SDSS J100535.24+013445.7 between 800 and 819 Å depicting how the flux is depressed by a partial LLS with a redshift of 0.836. The purple lines represent the placement of the Lyman lines used to determine the redshift of the LLS. The thinnest green line is the spline fit.

Composite Spectra

Figure 4: (Above) Power-law indices for each of the 150 AGNs organized by ionization classification from NED.

Results

- The 150 AGN exhibit a wide range of individual spectral indices (1<α<2.5).
- The FUV spectral index (α=0.75) for the 150-AGN composite is in agreement with the HST/FOS index (α=0.72) from Telfer et al. (2002) and the COS130L nearby HST/COS value (α=0.68) from Shull, Stevans, and Danforth (2012).
- The EUV spectral index (α=1.26) for the 150-AGN composite is harder than the HST/FOS value (α=1.57) from Telfer et al. (2002) and the HST/COS value (α=1.41), but it is softer than the FUSE value (α=0.56) from Scott et al. (2004).
- Spectral indices of the high-z and low-z subsample composites in agreement with the overall composite confirming that our normalization procedure is robust.
- The "gap composite" shows that limited spectral coverage hinders the fitting of a spectral break, which could explain why the FUSE composite in Scott et al. (2004) did not appear to exhibit a turnover in slope.

Sample Characteristics

Figure 5: (Above) Power-law indices for each of the 150 AGNs vs. redshift. In this case, redshift is a surrogate for wavelength coverage because the FUV is probed by observing low-z AGNs and the EUV is probed by high-z AGNs. The black vertical dashed lines divide the AGNs into the sub-samples used in the composites below.

Future Work

- Compile a composite spectrum with all available COS G140L observations (N=1314).
- Extend Composite down to 304 Å with observations of quasars used to study the Ly II Gunn-Peterson Effect (G140L and G130M observations).
- Use results of COS low-redshift IGM survey to mask out the thousands of absorption lines in the EUV and build a composite that does not rely on the derived spline fits.