THE FIRST HUBBLE/COS EXTREME-ULTRAVIOLET AGN COMPOSITE SPECTRUM

Matthew L. Stevans, Jr. 1, J. Michael Shull1, Charles W. Danforth1
1CASA, University of Colorado at Boulder

Abstract
The high-throughput Cosmic Origins Spectrograph (COS) installed on the Hubble Space Telescope (HST) allows us to obtain high-quality UV spectra of active galactic nuclei (AGNs), many of which serve as background targets for studies of the low-redshift intergalactic medium (IGM). We present a composite spectrum produced by stacking spectra of 22 AGNs with redshifts 0.026 < z < 1.44, sufficient to explore the far ultraviolet (FUV) and extreme ultraviolet (EUV) ionizing continuum. We fit the composite’s underlying smooth continuum with a power-law, F \alpha \nu = \nu^{\alpha_{\nu}}, with index \alpha_{\nu} = 1.59 \pm 0.3, and identify highly ionized broad emission lines (Ne VIII, O V, O IV, C IV, O III). We compare our COS-based power-law continuum fit to previous spectral fits from the Faint Object Spectrograph (HST/FOS/GHRS) (Telfer et al. 2002) and Far Ultraviolet Spectroscopic Explorer (FUSE) (Scott et al. 2004).

Motivation
The EUV (100-1200 \(\AA\)) and FUV (1200-2000 \(\AA\)) portions of AGN spectral energy distributions (SEDs) contain continua and emission lines that are diagnostics of the accretion disk and broad-line regions. Unfortunately, observing wavelengths below 912 \(\AA\) is not possible due to H I absorption in the interstellar medium (ISM). However, measuring the FUV and EUV continua of AGN at high redshifts can be done in the visible, but the continua are increasingly carved up by Ly-\alpha absorption from the IGM. With FUV spectrographs like HST/COS, we have optimal access to the EUV for AGN at z > 0.24.

Results
- We find a wide range of spectral indices (-1.73 < \alpha_{\nu} < 0.25) for the individual spectra.
- The composite of all 22 QSOs in our sample shows a spectral break around 1000 \(\AA\), see center panel of Figure 3, with an EUV index of \alpha_{\nu} = -1.5, and an FUV index of \alpha_{\nu} = -0.73. Estimated uncertainties: +/0.2.
- Our measured EUV index agrees with Telfer et al. (2002) value of \alpha_{\nu} = -1.57+/0.17 for radio-quiet QSOs.
- The composite spectrum constructed with the individual spline fits avoids the accumulation of Lyman-\alpha absorption at the shortest wavelength, therefore we quote the spectral index associated with the spline composite.

Improvements
Over
Previous
Composites
1. Greater wavelength coverage by COS (1135-1750 \(\AA\) observed; medium-resolution gratings: G130M and G160M) as compared to FUSE (905-1187 \(\AA\) observed), which was used by Scott et al. (2004), ensures that each spectrum contains at least two line-free continuum windows. This results in:
   • more accurate individual spectrum fits, improved normalization during the composite construction process,
   • and clear identification of break at 1000 \(\AA\) with two index-free fit composite.
2. The high signal-to-noise ratio of COS data allows clear identification of EUV emission lines (Ne VIII, O III, O IV, and C IV) in our composite. This was not possible with the HST/FOS/GHRS composite.
3. Using the spline fits of the individual spectra for normalization to the composite spectrum avoids the negative effect of normalizing with data that includes Lyman-\alpha absorption.

Future
Improvements
While our small sample size (22 QSOs) and limited redshift range (0.26 < z < 1.44) are enough to characterize the mean index, it falls short of Telfer et al. (2002) (sample: 184 QSOs; redshifts: 9.3 < z < 3.6). We will be analyzing additional AGN spectra as the become available. These will include all intermediate-redshifts that probe the rest-frame Lyman Continuum.

References

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