THE SDSS/2XMM BALQSO SAMPLE

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Introduction

Broad Absorption Line Quasars (BALQSOs) provide the most compelling evidence for the presence of massive winds/outflows from the inner regions of AGN. They are known to be rather dim in X-rays, and until now a two-fold strategy has been pursued in order to investigate their high-energy properties. A hardness ratios and/or stacking analysis technique was applied to snapshot observations of large numbers of sources, while detailed spectral analysis of deep observations was possible only for a few bright sources. Both kind of studies revealed the presence of intrinsic absorbing column densities of 10^{22-24} cm^{-2}. Thanks to the current availability of both optical and X-rays public catalogs we have been able to make a step forward to join the two above-mentioned strategies and drew a large sample of 57 BALQSOs at medium/high redshift. We performed X-ray spectral analysis on the sources with best statistics, while hardness ratios analysis will be performed on the remaining sources. This will allow us to constrain both mean and specific properties of the sample and get insight into the physics of AGN winds.

The Sample

We cross-correlated the Sloan Digital Sky Survey DR5 (SDSS DR5) Quasar Catalog (Schneider et al. 2007) with the Second XMM-Newton Serendipitous Source Catalog (2XMM, Watson et al. 2008 in prep.) and found 57 sources classified as BALQSOs according to Trump et al. 2006 and/or to Shen et al. 2007. The redshift distribution of the sources is shown in Figure 1 and covers the range 0.8 < z < 3.8. We performed X-ray spectral analysis on the 23 BALQSOs with best statistics and here we present the results. For the remaining 34 sources we are performing a hardness ratios analysis technique in order to investigate both mean and specific high-energy properties of the sample and get insight into the physics of AGN winds.

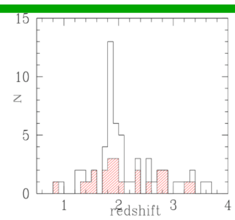

FIG. 1. Redshift distribution of the 57 sources of the sample. Red bins are the 23 sources with statistics good enough to perform X-ray spectral analysis, presented in this work.

Data Analysis Results

We modeled the spectrum of each source with a power law absorbed by Galactic neutral hydrogen plus neutral absorption at the redshift of the source. The sample mean photon index is $<\Gamma> = 1.94 \pm 0.23$ and thus compatible with the typical values of radio quiet type 1 AGN (Figure 2). Given the low statistics we were not able to adopt more complex models (i.e. ionized and/or partially covering absorbers), however spectral fits are statistically very good for all the sources.

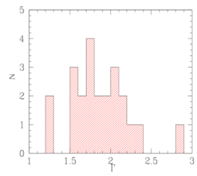

FIG. 2. Best-fit photon index distribution

The intrinsic neutral absorber column density distribution is shown in Figure 3. While we expected a $< N_H > \sim 10^{23}$ cm^{-2} (see e.g. Gallagher et al. 2006), we found 15 out of 23 sources with only upper limits on the amount of intrinsic neutral absorption. Of these, 7 sources present $N_H < 4 \times 10^{21}$ cm^{-2} at 90% confidence level. We checked N_H dependence on both redshift and statistics, and found no significant correlation.

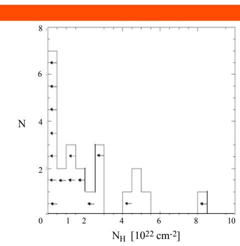

FIG. 3. Number distribution of column densities of neutral absorption at the source, in units of 10^{22} cm^{-2}. Arrows indicate upper limits at 90% confidence level.

We checked our results by measuring optical/X-ray spectral index α_{ox} computed at 2500 Å and 2 keV and comparing it with the α_{ox}(l2500) expected on the basis of the most update rest-frame 2500 Å luminosity density-α_{ox} correlation (Just et al. 2007). Results are shown in Figure 4. The measured α_{ox} are consistent within errors with the ones expected for radio-quiet type 1 AGN. This result is surprising given the known "soft X-ray weakness" of BALQSOs (e.g. Green & Mathur 1996, Green et al. 2001, Gallagher et al. 2006) who often present observed $\alpha_{ox} < -2$, but is consistent with the spectral analysis findings of no or little absorption for a large number of sources.

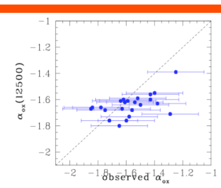

FIG. 4. Optical/X-ray spectral index α_{ox} measures for our sources versus α_{ox}(l2500) expected from the correlation of Just et al. 2007

Conclusions

We found a large fraction of the SDSS/2XMM BALQSOs unabsorbed in X-rays . We were able to place stringent upper limits on neutral column density at the source and found $N_H < 4 \times 10^{21}$ cm^{-2} for 7 out of 23 sources. Only 5 out of 23 sources present absorption significant at >99% confidence level. The underlying continuum is a power law with photon index $\Gamma \sim 2$. The measured α_{ox} are consistent with the ones expected from rest-frame 2500 Å luminosity density. This result is surprising given both our knowledge of the X-ray properties of BALQSOs and the theoretical accretion disk wind models expectations. We are further investigating the X-ray properties of the remaining sources of the sample in order to understand what causes this unexpected, unabsorbed scenario.