XMM-NEWTON AND DEEP OPTICAL OBSERVATIONS OF THE OTELO FIELDS: THE GROTH-WESTPHAL STRIP

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ABSTRACT

We present a preliminary analysis of public EPIC data of one of the OTELO targets, the Groth-Westphal strip, gathered from the XMM-Newton Science Archive (XSA). EPIC images are combined with optical $BVRI$ data from our broadband survey carried out with the 4.2m WHT at La Palma.

Key words: X-rays: surveys; X-rays: background; AGN; galaxies: morphology.

1. THE OTELO PROJECT AND ITS SCIENCE

OTELO (Cepa et al., 2003) will search for emission line objects using OSIRIS tunable filters at the 10m GTC telescope in La Palma in selected atmospheric windows (centred at the H_α line at z = 0.24 and z = 0.4) that are relatively free of sky emission lines. A total area of more than one square degree will be observed. The survey technique will allow for separation of the H_α and [NII] lines and therefore AGNs from starburst galaxies. A 5σ depth of 8×10^{-18} erg cm^{-2} s^{-1} will make OTELO the deepest emission line survey to date. OTELO science includes the evolution of galaxies, the evolution of star formation in the Universe, chemical evolution of galaxies, QSO spatial density determination, AGN evolution, the low-end of the galaxy luminosity function, galactic Astronomy etc. A complementary optical broadband survey is currently on-going (morphology, photometrical redshifts). It is intended to complement the optical survey with other ground or space-based facilities, from X-rays (XMM-Newton, Chandra) to FIR and sub-mm (Herschel, GTM). The present work is being performed in the framework of the multiwavelength study of the OTELO fields.

2. OBSERVATIONS AND DATA REDUCTION

XMM-Newton observations of the Groth-Westphal strip (Groth et al., 1994) were collected from the XMM Science Archive (XSA). The EPIC observations were reprocessed using SAS v6.0.0 `emproc` and `epproc` standard procedures. High-radiation intervals were removed by inspecting the count rate curves. GTI files were created by means of the `tabgtigen` SAS task. These files were further included in standard filtering expressions. The observations were co-added by means of the SAS `merge` procedure. Attitude files were also merged. Final exposure times were about 82 ksec and 70 ksec in MOS and PN, respectively. Three energy bands were defined: 0.5 - 2 keV (soft band), 2 - 4.5 keV (medium band) and 4.5 - 10 keV (hard band). Sources were detected by means of the `edetect_chain` SAS procedure. We imposed a likehood parameter $ML = -\ln(1 - P) > 14$, were P is the probability that the source exists. Furthermore, we considered only those sources for which $flux/err_{flux} > 2$, lying within the optical FOV. We have detected 75 sources fulfilling these conditions. Two hardness ratios have been also computed by this SAS procedure.

Optical $BVRI$ observations were carried out at the prime focus of the 4.2m William Herschel Telescope (WHT) of the Observatorio del Roque de los Muchachos (La Palma). Image size is 16' $\times$ 16' with a plate scale of 0.24 arcsec/pixel. Total exposure time at each of the three pointing directions is 9000 sec per filter. Reduction process followed standard steps using IRAF packages. Photometric calibration was obtained with several Landolt standard fields. Absolute astrometry was performed using the USNO B1 catalogue. Sources were extracted using Sextractor 2.2 (Bertin & Arnouts, 1996). The 50% detection level is 25.3 in B, 25.3 in V, 24.7 in R and 23.5

in I. Details on the optical observations can be found in Pérez-García et al. (in preparation).

3. SOURCE DETECTION

We have matched X-rays and optical sources by searching in 6” × 6” boxes centred in the X-rays sources coordinates. Upon comparison with published Chandra coordinates (Nandra et al., 2004) we found a bulk shift of $\langle\Delta\alpha\rangle = 4.5$” and $\langle\Delta\delta\rangle = -2.7$”. After correcting for this global image shift, we found: *(a)* Unique match in all photometric bands for 43 sources (57.3%); *(b)* partial match (not detected in all bands) for 10 sources (13.3%); *(c)* multiple match for 10 sources (13.3%); *(d)* partial match + multiple match for 2 sources (2.7%); and *(e)* No optical counterpart found for 10 sources (13.3%)

4. RESULTS

Since photometric redshift values are still not available, we have concentrated our analysis in distance-independent parameters, as described below.

4.1. X/O Ratio Analysis

The X-rays to optical flux ratio (X/O) is a powerful means to discriminate between different classes of X-rays sources (Fiore et al., 2003; Della Ceca et al., 2004). Figure 1 shows a diagnostic diagram combining the 0.5-4.5 keV to optical R-band flux ratio and one of the hardness ratios. The dashed-dotted line corresponds to X/O = 0.1, typical of coronal-emitting stars, normal galaxies and heavily absorbed AGNs. Five of our sources (11.6%) lie below this line, and therefore are likely either normal galaxies or Compton-thick AGNs. The dashed-line box corresponds to the region containing the 85% of the optically identified broad-line AGNs in the XMM-Newton Bright Source Sample (BSS) (Della Ceca et al., 2004). 29 of our sources (67.4%) fall within the broad-line AGN region defined by this box. Objects with harder HR and large X/O (i.e. those to the right of the broad-line box) are likely narrow-line AGNs, according to the BSS and HBSS diagnostics from Della Ceca et al. (2004).

4.2. B/T Relation

We have derived the B/T (bulge-to-total luminosity) relation for the sample objects, comparing its distribution with a sample of active galaxies in the local Universe (Sánchez-Portal et al., 2004), as shown in figure 2. While not incompatible, B/T distributions are likely different, as proven by means of a K-S test: null hypothesis (that both samples are drawn from the same distribution) significance is only 17%. If we exclude LINERs from the local Universe sample (i.e. considering only Seyfert galaxies), the null hypothesis significance is higher but still reduced, 39%. The X-rays selected sample tends to higher B/T values and lacks very low B/T objects (generally present in latest Hubble types, T ≥ 4). Finally, we don’t find any correlation between X-rays hardness ratios and the B/T ratio.

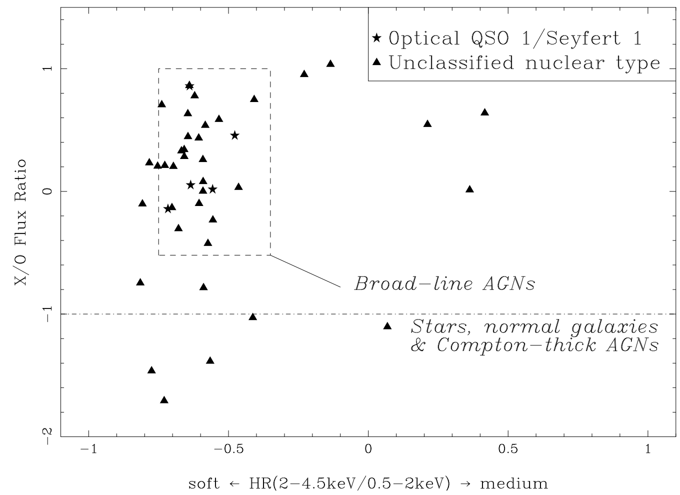

Figure 1. X/O relation vs. hardness ratio

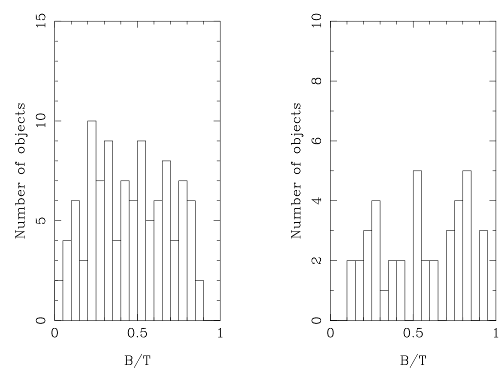

Figure 2. B/T relation in the local Universe (left) and in the X-rays selected sample

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