OTELO Survey: Properties of X-ray Emitters in the Groth Field

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Abstract

We present results from the study of broadband optical and X-ray properties of a large sample of active galactic nuclei in the Groth-Westphal Strip (GWS) field. In order to determine the morphology of all objects, we obtained different structural parameters. Combining these parameters with other optical/X-ray properties, we were searching for possible correlations between them, which could point out some of the AGN characteristics and allow us to separate between starbursts and AGNs as well as different types of AGNs.

OBSERVATIONS

Optical data (WHT, La Palma)

Three areas have been observed in the GWS field with broadband BVRI filters, with the total exposure time ranging from 8400 to 10000 sec and a total covered area of ~0.18 sq deg. Our limiting magnitudes are B 25, V 25, R 24.5 and I 24. The final catalog contains ~45000 objects.

(Cepa et al., 2008, submitted)

X-ray data (Chandra)

We have used public data of three ACIS-I pointings in the deep 200ksec, small ~0.2 square degrees area survey. Data were processed using CIAO v3.3.0.1. Five energetic bands have been selected in the range 0.5-7 keV; the final catalog contains 639 sources.

(Sánchez-Portal et al. 2005)

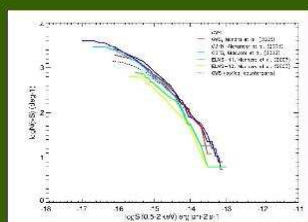
OPTICAL CATALOG + X-RAY CATALOG CROSSING

Final catalog of 340 X-ray emitters with optical counterparts that we are using through morphology/nuclear type classification and diagnostic diagrams analysis (Completeness = 97.07% Reliability = 88.91%)

X-ray number counts

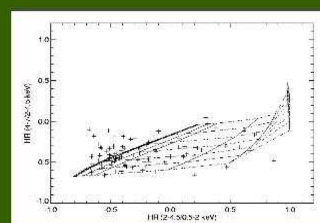
We have calculated the limit flux in the full band of $2.5 * 10^{-16}$ erg cm^{-2} s^{-1}. We show the cumulative number count distributions (logN-logS) in soft band, for all X-ray detections (black solid line) and for the detections with optical counterparts (black dotted line).

For comparison, we also show the distributions of other five deep surveys, as it is marked on the picture, including the GWS data of PI Nandra et al. 2005. In general, at our flux limit the number counts of out total X-ray sample are in good agreement with other represented surveys.



X-ray color-color diagram

We have represented detected X-ray sources (marked here with crosses) on the X-ray color-color diagram, superposing them on an absorbed power low model grid.



Photon index is varying between 0 and 3 with a bin of 0.5 and a log of absorption column density between 20 and 24 in steps of 0.5. In general, sources are located inside the grid, suggesting that their spectrum can be properly represented by power low with different absorption column densities.

ANALYSIS AND RESULTS

Structural parameters obtaining and morphology classification

Using SExtractor (Bertin and Arnouts et al. 1996) and GIM2D (Simard et al. 1998) we have computed several morphological parameters of the optical counterparts, including concentration and asymmetry indexes, residual parameter, bulge-to-total ratio and SExtractor CLASS_STAR parameter for the compact object selection. To check the reliability of all obtained structural parameters we also applied the visual inspection for all objects, observing different types of galaxy profiles and its counter diagram obtained by imexamine IRAF tool. We have seen that when dealing with faint objects (R<24) with small isophotal area (<200 pixels), the combination of the concentration index with the asymmetry index gives us the most reliable morphological classification.

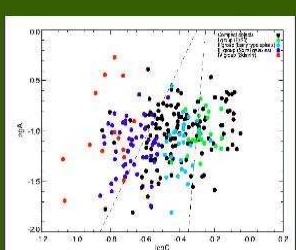
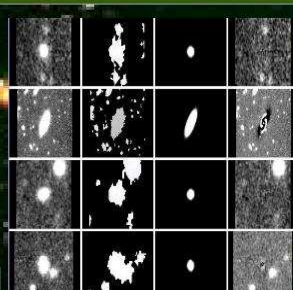
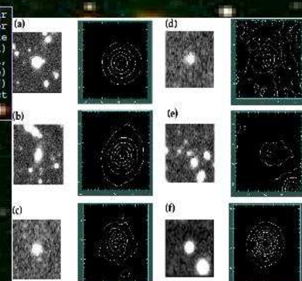


Diagram shows the morphological classification using concentration-asymmetry index relation. Dotted lines represent the limits between E/S0, spiral and Irr galaxies from of Abraham et al. (1994), using HST data. Comparing with these results we can notice a shift of our late type galaxies to lower C values, which can be explained as a seeing effect in our ground-based data.



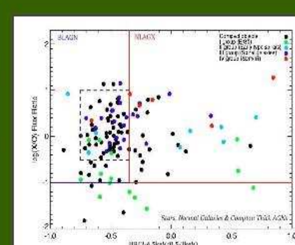
Sample of science images for four galaxies and their mask (obtained with SExtractor), model and residual (obtained with GIM2D after modeling) images

Sample of contour plots for different Hubble type galaxies: a) E/S0, b) S0/S0a, c) Sab, d) Scd, e) Sdm/Irr & f) compact object (CLASS_STAR>0.9)



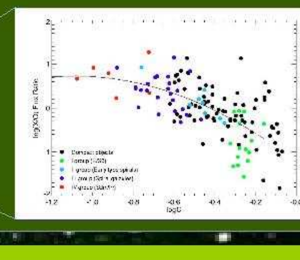
Nuclear type classification

We propose a rough classification criterion into BLAGN, NLAGN and normal galaxies/Compton-thick AGN/stars based on X-ray-to-optical ratio (X/O) and 2-4.5keV/0.5-2keV hardness ratio (HR) (Della Ceca et al. 2004). Following this criterion, we find that 61% of the objects can be classified as BLAGN. There is no clear separation between different morphological and nuclear types, but we can notice that most of our objects classified as compact (CLASS_STAR>0.9) are situated in the region of BLAGNs.



X/O Flux Ratio – Concentration index anticorrelation!!!!

We were combining different structural parameters with the X-ray/optical object properties in order to find the correlation between some of them which than could provide us the diagnostic diagrams for the morphology/nuclear type separation. We have seen a clear anticorrelation between the X/O ratio and the concentration index (morphology) suggesting that late type galaxies have a higher X-ray nuclear activity relative to the luminosity of the host galaxy. This result could suggest that the accretion rate in the early type objects, whose environment is poor in gas, is lower than in late type galaxies, housing larger stocks of fueling material to sustain the AGN.



Future Prospects:

Our goal is the study of AGN population in the deep X-ray (Chandra and XMM-Newton), optical (WHT and GTC) and IR (Spitzer and Herschel) surveys. Combining different galaxy properties in these three ranges, we are using obtained diagnostic diagrams to separate between different nuclear types, and we are measuring photometric redshift for the selected AGNs. We are interested in luminosity function determination, its analysis and the study of its evolution.

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