Heavily obscured AGN in the local Universe

P. Severgnini^{*,†}, A. Caccianiga^{*}, R. Della Ceca^{*}, A. Moretti^{*}, C. Vignali^{**}, V. La Parola[‡] and G. Cusumano[‡]

*INAF-Osservatorio Astronomico di Brera [†]e-mail: paola.severgnini@brera.inaf.it **Dip. di Astronomia, Univ. degli Studi di Bologna [‡]INAF-IASF Palermo

Abstract.

We present here a new powerful diagnostic plot to select heavily obscured AGN in the local universe by combining infrared (Spitzer, IRAS) and X-ray (XMM) information. On the basis of this plot, we selected a sample of X-ray obscured sources in the 2XMM catalogue and found seven newly discovered Compton-thick AGN candidates.

Keywords: Active Galaxies: X-ray, Infrared PACS: 98.54.Cm: 95.85.Nv, 95.85.Hp

THE DIAGNOSTIC PLOT AND THE IRAS-2XMM SAMPLE

The Diagnostic Plot. Despite their cosmological relevance, less than two dozens of confirmed heavily obscured, Compton–thick (Nh>10²⁴ cm⁻²) AGN have been found so far. We propose a new diagnostic plot to select Compton-thick AGN candidates in the local universe. The plot is based on the combination of the F(2–10 keV)/(v_{IR} F_{IR}) flux ratio (where IR is either 24 μ m (Spitzer) or 25 μ m (IRAS)) with the XMM-Newton color (hardness ratio, HR). While the F(2-10 keV)/(v_{IR} F_{IR}) flux ratio allows us to separate heavily obscured AGN candidates and starburst galaxies from less obscured (Nh<5×10²³ cm⁻²) AGN ([1]), the X-ray color is able to separate starburst (HR<-0.1) from obscured AGN (HR>-0.1). The region of Compton-thick AGN candidates is marked in Figure 1 (left panel).

The IRAS-2XMM Sample. To test the proposed diagnostic plot in selecting Compton-thick AGN, we have cross-correlated the IRAS Point Source Catalog (PSC) v2.1 with the bright end (F(4.5-12 keV)> 10^{-13} erg cm⁻² s⁻¹) of the incremental version of the 2XMM catalogue ([2]). We find that 47 IRAS sources populate the region of the Compton-thick AGN candidates, 46 of which are extra-galactic sources (hereafter the IRAS-2XMM sample, Fig. 1, right panel). For all but one source, the spectroscopic classification is already available in the literature. Up to now, we have performed a preliminary X–ray analysis for 40 out of the 46 sources. Twenty–four of them are already known as Compton–thick AGN in the literature (10 have also high energy data that confirm their nature). Among the remaining 16 sources, there are 9 obscured but Compton-thin sources and 7 newly discovered Compton–thick emission). For one of them a preliminary analysis of SWIFT-BAT ([3]) and Suzaku (proprietary data)



FIGURE 1. Left Panel: $F(2-10 \text{ keV})/(v_{24} F_{24})$ vs. HR4 (defined using the two following bands: 2-4.5 keV and 4.5-12 keV) for a large sample of AGN already studied in the literature. Filled triangles in the upper quadrants are Compton-thin AGN (Nh<<10²⁴ cm⁻²) taken from the HBS sample ([4]) and the XMDS survey ([5]). The only triangle in the lower–right quadrant is a Compton-thick candidate according to [5]. Stars are a sample of local starburst galaxies ([6]) and open squares are local "confirmed" Compton-thick AGN from [7]. Right panel: $F(2-12 \text{ keV})/(v_{25}F_{25})$ vs. HR4 diagnostic plot for the sources resulting from the IRAS-2XMM cross-correlation. The sources belonging to the IRAS-2XMM sample populate the lower–right quadrant. Open squares are the 24 Compton–thick already known in the literature, filled squares are the 7 newly discovered Compton–thick candidates and the filled triangles are the 9 Compton-thin AGN. No X–ray analysis has been performed yet for small filled circles.

data confirms our classification as a Compton–thick AGN (Severgnini et al. in prep.). In conclusion, of the 40 sources already analyzed so far we find that all of them are obscured and at least \sim 75% of them are Compton–thick AGN. We thus demonstrate that the X-ray/IR flux ratio, along with the X–ray color, can be used to efficiently select local (z<0.1), heavily obscured and Compton-thick AGN.

ACKNOWLEDGMENTS

We acknowledge financial support from ASI (grant n. I/088/06/0 and COFIS contract).

REFERENCES

- 1. Severgnini, P., Della Ceca, R., Caccianiga, A., et al. 2007, NCimB 122, 1021
- 2. Watson, M. G., Schroder, A. C., Fyfe, D., et al. 2009, A&A 493, 339
- 3. Cusumano, G. 2009, AIPC 1126, 104
- 4. Della Ceca, R., Caccianiga, A., Severgnini, P., et al. 2008, A&A 487, 119
- 5. Polletta M., Tajer, M., Maraschi, L., et al. 2007, ApJ 663, 81
- 6. Ranalli, P., Comastri, A., Setti, G. 2003 A&A 399, 39
- 7. Della Ceca, R., Severgnini, P., Caccianiga, A., et al. 2008, MmSAI 79, 65