OPTICAL IDENTIFICATION IN THE XMM-NEWTON MARANO FIELD SURVEY

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ABSTRACT

We present optical follow-up observations of an overlapping raster of XMM-Newton observations with a total of 120 ksec good observation time in the Marano Field. The Marano Field was originally an 0.7 deg^2 optical quasar survey field. Among almost 700 X-ray sources we detected most of the optically selected quasars. We obtained VLT FORS1 and FORS2 multi-object spectroscopy and identified 99 new X-ray counterparts. Almost half of the new XMM-Newton sources are heavily absorbed sources which were typically identified with narrow line objects (type II AGNs) or optically normal galaxies. The X-ray identification completeness ratio of the area covered by VLT FORS1 and FORS2 data reaches 50%. Type I AGNs extend over a wide range of redshift ($0.4 < z < 2.8$) with a maximum at $z \sim 0.9 - 1.4$. Type I and type II AGNs are comparable in number up to $z = 1$. Type I AGNs are the dominant population at $z > 1$. However, we found 5 type II AGNs with significant cosmological redshifts of up to $z \sim 2.8$. All the X-ray emitting optically normal galaxies with high X-ray luminosities show hard X-ray spectra.

Key words: surveys; X-rays; galaxies: active; quasars.

1. INTRODUCTION

The Marano Field was named by an early optical quasar survey up to a limiting magnitude of $m_{B_J} = 22.0$ mag by Marano et al. (1988). Based on different selection techniques, they discovered 23 broad emission line quasars and defined a list of quasar candidates. Zitelli et al. (1992) completed this work by presenting a spectroscopically complete sample of quasars with $m_{B_J} \leq 22.0$ mag.

2. OPTICAL IDENTIFICATION OF THE X-RAY SOURCES

In the central Marano Field (0.28 deg^2) we detected 525 X-ray sources out of which 475 are new detections ($f_X \geq 2 \times 10^{-15}$ erg cm^{-2} s^{-1}), the remaining 50 have been already detected by ROSAT (56 ksec, $f_X \geq 3.7 \times 10^{-15}$ erg cm^{-2} s^{-1}) Zamorani et al. (1999). Based on the literature 56 X-ray sources have been already identified with optical counterparts (La Franca et al., 2002; Gruppioni et al., 1999, 1997; Teplitz et al., 2003). In order to complete our sample we obtained VLT FORS1 and FORS2 multi-object spectroscopy for newly detected X-ray sources. We were able to identify a total of 83 new X-ray sources with optical counterparts ($m_R \leq 24.0$ mag) in the central region of the Marano Field. The breakdown of the identifications according to object classes is shown in Tab. 1.

object class	total number	percentage
type I AGNs	83	59.7 %
type II AGNs	38	27.3 %
galaxies (G)	9	6.5 %
stars (S)	9	6.5 %

Table 1. X-ray counterpart distribution of the central Marano Field

3. DISCUSSION

We identified different object classes as counterparts for the X-ray sources in the central Marano Field. Over 80% of the X-ray sources are AGNs. Fig. 1 shows the redshift distribution of different object classes. Type I AGN extend over a wide range of redshift with a maximum at $z \sim 0.9 - 1.4$. Type II AGN are detected at lower number density at low redshifts and peak at $z \sim 0.3$ and $z \sim 0.8 - 1.0$. We also classified five high redshifted type II AGN. The lack of type II AGNs between $z = 1.5 - 2.2$

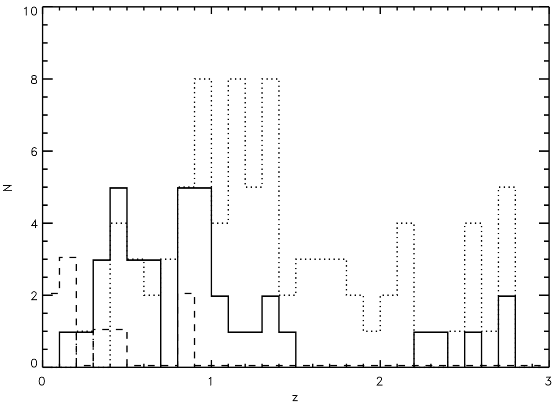

Figure 1. Redshift distribution of different object classes. Labels: dotted line - type I AGNs, solid line - type II AGNs, dashed line - galaxies.

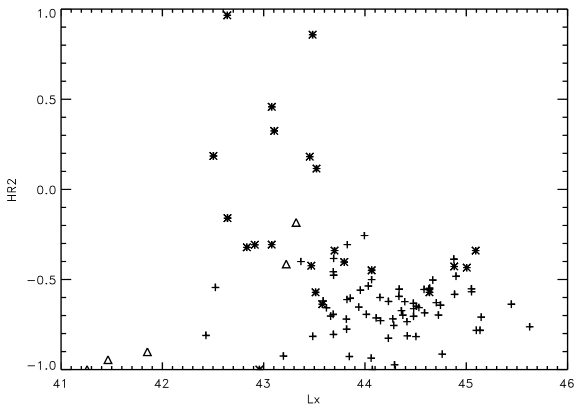

Figure 2. Hardness-ratio (0.5-2.0 keV & 2.0-4.5 keV) vs. X-ray luminosity (as observed). Plotted are objects with errors in hardness-ratio $\leq$ 0.3. Labels: cross - type I AGNs, asterisks - type II AGNs, Triangle - galaxies.

is probably due to missing emission lines in the optical window. Taking this into account the redshifts are consistent with a flat distribution of type II AGN at $z > 1.0$. X-ray emitting galaxies are only found at low redshifts ($z < 0.9$).
In addition to classifying the optical counterparts we furthermore studied the properties of the different object classes that could be identified with X-ray sources.

All type I AGN in Fig. 2 show high X-ray luminosities and soft X-ray spectra. The unabsorbed type I AGNs vary just over a small range in hardness-ratio. In contrast, type II AGN and X-ray emitting galaxies show lower X-ray luminosities and very hard X-ray spectra. However, their hardness-ratio differs from extremely obscured objects to almost unobscured objects (see Fig. 2). Nevertheless, the majority of type II AGNs and X-ray emitting galaxies show only narrow line emissions from outside the central region. Type II AGN are optically fainter and redder than type I AGN (see Fig.3). The optical spectrum of X-ray

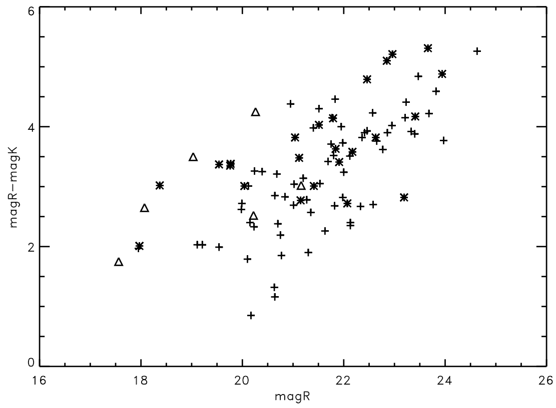

Figure 3. Colour magnitude diagram of identified X-ray sources. Labels: cross - type I AGNs, asterisks - type II AGNs, Triangle - galaxies.

bright optically normal galaxies, so called ”XBONGS”, indicates nothing that points towards an AGN. The AGN inside this galaxy is so heavily absorbed that all optical line emissions are completely obscured. This is also indicated by the hard spectra of XBONGS. Interestingly, XBONGS do not stick out as a separated object class in a hardness-ratio–X-ray luminosity diagram. They share most of the X-ray properties of type II AGNs.

4. ACKNOWLEDGEMENTS

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