This paper presents the analysis of a statistically complete sample of 28 serendipitous X-ray sources selected in 82 pointed XMM-Newton fields down to a count-rate of 0.002 counts s$^{-1}$ (4.5-7.5 keV energy band). This is the first sample selected in this energy range to have complete spectroscopic identifications and redshift determinations for all the objects. Apart from one Galactic source (an interacting binary), all the objects are AGNs. Their optical and X-ray properties (derived from the spectral analysis of the XMM-EPIC data) are compared together. The good correlation between the optical spectral type and the X-ray absorption properties supports the AGN unified model. Only one object that does not fit the relation between optical and X-ray absorption is found, namely a Seyfert 1.9 with no evidence of obscuration.

The XMM-Newton fields were chosen to be complementary to previous surveys, aiming at maximising the flux of AGNs. This choice allowed us to study a unique sample of obscured AGNs, in particular, play a key role in the XRB synthesis models since they are expected to make up a significant fraction of the population in hard X-ray energies (see Fabian 2003 and references therein). On the contrary, only a small fraction of absorbed AGNs is found in soft X-ray surveys even at the faintest fluxes (e.g. ∼15% in the ROSAT Ultra Deep Survey, Lehmann et al. 2001).

Many important issues related to this population are still to be understood, like the number of type 2 QSO, the relationship between optical absorption and X-ray obscuration (e.g. Maccacaro, Perola & Elvis 1982; Panessa & Bassani 2002; Risaliti et al. 1999; Maiolino et al., 2001), the evolutionary properties of type 2 AGNs (Gilli, Salvati & Hasinger 2001; Franceschini et al. 2002) and the nature of the “Optically dull X-ray loud galaxies”, firstly discovered from the analysis of Einstein and ROSAT data (e.g. Elvis et al. 1981; Maccacaro et al. 1987; Griffiths et al. 1995; Tananbaum et al. 1997) and more recently found in large number by Chandra and XMM-Newton surveys (Fiore et al., 2000; Barger et al. 2002; Comastri et al. 2002; Severgnini et al. 2003).

Many of these issues can be studied by using hard X-ray surveys with complete spectroscopic information, both in the optical and in the X-rays, to allow a direct comparison between the two bands (e.g. Akiyama et al. 2003; Ueda et al. 2003). In particular, AGN samples selected in the hardest energy band currently reachable with imaging instruments, i.e. the 5-10 keV or 5-8 keV energy band, provide the best starting point for this kind of analysis since they are less affected by obscuration.

However, the sources found in medium-deep surveys are usually so faint in the optical that the completion of the identification process is hard, if not impossible, to achieve. For instance, about 25% of the sources discovered in the Chandra Deep Fields have optical counterparts fainter than R=25 (Giacconi et al. 2002) making the direct redshift estimate very difficult even with the largest optical telescopes currently available. Furthermore, an accurate X-ray spectral analysis is usually not feasible for the faintest sources detected in...
Deep surveys. Bright X-ray surveys, for which a complete spectroscopic identification in the optical is a feasible task and for which the X-ray spectra can be easily collected, thus complement medium and deep surveys.

With this goal in mind, the XMM-Newton Survey Science Centre (SSC) The XMM-Newton SSC is an international collaboration appointed by ESA to help the SOC in developing the SAS, to pipe-line process all XMM data and to exploit the XMM-Newton serendipitous detections. See http://xmmssc-www.star.le.ac.uk/ for a description of the SSC activities. s building up a large (∼1000 sources) sample of bright (flux limit \(\sim 10^{-13} \text{ erg cm}^{-2} \text{ s}^{-1}\)) serendipitous XMM-Newton sources at high Galactic latitude \((|b| > 20^\circ)\), following well defined criteria so as to allow both a detailed study of sources of high individual interest as well as statistical population studies (see Della Ceca et al. 2002; Della Ceca 2002).

The scope of this paper is to present a first complete and representative sub-sample of 28 objects, selected in the 4.5-7.5 keV energy range. Even if small, this sample has the important advantage that a classification based on dedicated optical spectroscopy is available for all the sources. In contrast, recent samples selected in a similar very hard energy band (∼5-10 keV) using BeppoSAX (Fiore et al. 1999; La Franca et al. 2002) ASCA (Nandra et al. 2003), XMM-Newton (Baldi et al. 2002; Fiore et al. 2003; Mainieri et al. 2002) or Chandra data (e.g. Rosati et al. 2002) are usually characterized by a partial identification level.

In Section 2 the sample is presented while in Section 3 and in Section 4 the optical and the X-ray spectra respectively are discussed. In Section 5 the X-ray and optical properties are compared together while in Section 6 the relative fraction of absorbed versus un-absorbed AGNs is compared to the predictions based on the X-ray background synthesis models. Finally, in Section 7 an estimate of the density of type 2 QSO at the flux limit of the survey is given while in Section 8 we briefly discuss the problem of the X-ray bright Optically Normal Galaxies. Summary and conclusions are presented in Section 9. Throughout this paper \(H_0=65 \text{ km s}^{-1} \text{ Mpc}^{-1}\), \(\Omega_\Lambda=0.7\) and \(\Omega_M=0.3\) are assumed.

The XMM-Newton Bright Serendipitous Source Sample

The XMM-Newton Bright Serendipitous Source (XMM-Newton BSS) sample is an ongoing project aimed at the selection of a statistically complete sample of X-ray sources serendipitously discovered in pointed XMM-Newton observations (see Della Ceca et al. 2002, Della Ceca 2002 for details). The XMM-Newton BSS consists of 2 complementary samples based on the XMM-Newton EPIC-MOS2 data and selected in the 0.5-4.5 keV and in the 4.5-7.5 keV energy range respectively. The reasons for using the MOS2 detector for the definition of the sample have been described in details by Della Ceca et al. (2002). The XMM-Newton BSS will be released to the public community (Della Ceca et al. in prep.) and, when combined with medium and deep X-ray surveys, will allow us to investigate on a wide range of luminosities and redshifts the properties of the sources responsible for the XRB at energies below 10 keV.

A pilot study: the HBS28 Sample

As a pilot study we have selected a representative sub-sample (the HBS28 sample) in the 4.5–7.5 keV energy range. In particular we have used the XMM-Newton MOS2 fields available to the XMM-Newton SSC until December 2002 and selected according to the criteria described in Della Ceca et al. (2002) and Della Ceca (2002) i.e.: enumerate

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the SSC activities.