THE FLUX AND ANGULAR DISTRIBUTION OF AXIS SOURCES

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ABSTRACT

We present here the XMM-Newton International Survey (AXIS) sample which is the largest homogeneous calibrated serendipitous medium-deep XMM-Newton X-ray source sample that currently exists, comprising a total of 1444 sources in 36 XMM-Newton fields, with a sky coverage of almost 5 square degrees. We have constructed samples in four different bands: Soft (0.5 - 2 keV), Hard (2 - 10 keV), XID (0.5 - 4.5 keV) and Ultrahard (4.5 - 7.5 keV, which is hardly explored so far), reaching fluxes of a few 10^{-15} cgs in the Soft and XID bands, and $\sim 10^{-14}$ cgs in the Hard and UltraHard bands.

We have combined our sample with other shallower and deeper XMM-Newton and Chandra samples to construct logN-logS distributions over very wide flux ranges. The $\log N - \log S$ were well fitted with broken power law models in all bands, except for the ultrahard band, in which there is no break down to our faintest fluxes.

We have also studied the large scale distribution of the medium flux X-ray sky, using the field-to-field cosmic variance in the number of sources, and the angular correlation function of the sources, finding evidence for large scale inhomogeneities.

In an accompanying presentation we discuss the optical identification status and results of a subsample, called XMS (XMM-Newton Medium Sample)

Key words: X-ray sources; logN-logS; angular distribution.

1. INTRODUCTION

The AXIS (An XMM-Newton International Survey: http://venus.ifca.unican.es/~xray/AXIS/) survey is the largest homogeneous calibrated sample of X-ray serendipitous sources at medium fluxes (Barcons et al., 2002). In this work we present some results on the flux and angular distributions of AXIS sources: the $\log N - \log S$ relationships and the two-point angular correlation function of the sources, respectively.

The AXIS sample comprises a total of 1444 different sources in 36 XMM-Newton fields. The overall sky coverage is almost 5 square degrees. We have constructed samples in 4 different bands: Soft (0.5-2 keV), Hard (2-10 keV), XID (0.5-4.5 keV) and UltraHard (4.5-7.5 keV). The UltraHard band is quite unexplored so far but it is starting to show some promising results. We reach fluxes of a few 10^{-15} cgs in the Soft and XID bands and $\sim 10^{-14}$ cgs in the Hard and UltraHard bands.

The overall shape of the X-ray spectra of the AXIS sources has been fitted by a simple power law model corrected by local absorption.

2. THE $\mathrm{LOG}\, N - \mathrm{LOG}\, S$ RELATIONSHIPS

To carry out our $\log N - \log S$ analysis we have added to our sample sources from other surveys in order to cover a wider flux range and therefore obtain more accurate results. In the Soft and Hard bands we have added sources from the CDF North & South (Bauer et al., 2004) at the faint end of our flux distribution while in the XID and UltraHard bands we have added sources from BSS and HBSS surveys respectively (Della Ceca et al., 2004), which are brighter than ours, in order to broaden our flux coverage.

Fits were carried out using a Maximum Likelihood algorithm that was performed over the individual sources (no binning was applied to the sources when fitting). Our $\log N - \log S$ distributions confirm the existence of a break at fluxes around 10^{-14} cgs in Soft, Hard and XID bands so a broken power law model was therefore used to perform the fits. In the UltraHard band, however, no break has been observed yet and a simple power law was applied to this case.

The slopes obtained are in good agreement with other fits previously done (Moretti et al., 2003; Baldi et al., 2002), fixing the uncertainties that Baldi et al. had at faint fluxes in the soft band when calculating the $\log N - \log S$ for

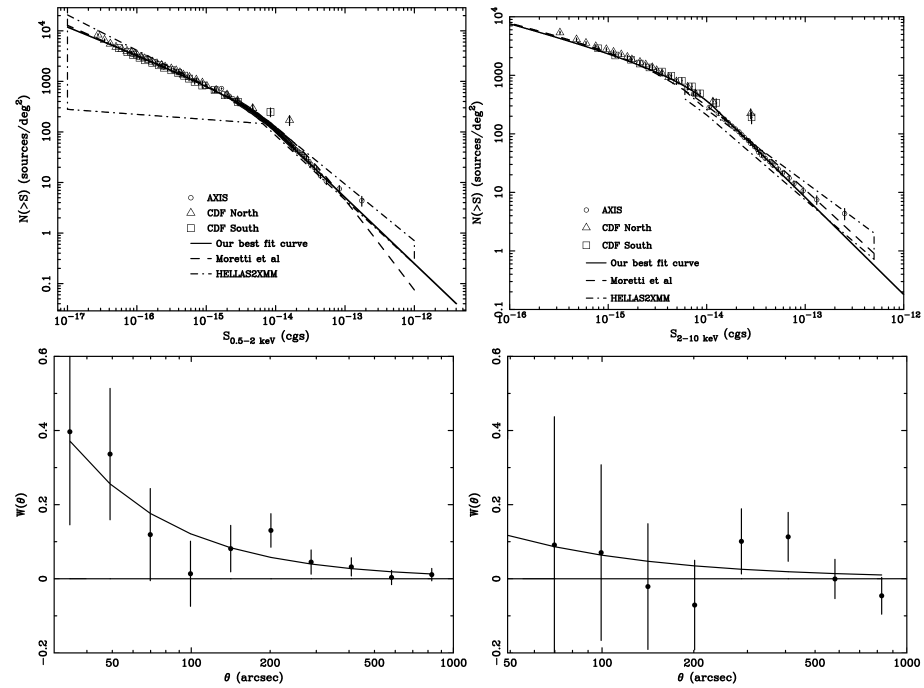

Figure 1. **Upper panels:** $\log N - \log S$ *plot for AXIS+CDF Soft (left) and Hard (right) sources. The solid line is our best fit curve. Dashed line is the fit from Moretti et al. (2003). Dot-dashed line are the results from Baldi et al. (2002) with the HELLAS2XMM survey.* **Lower panels:** *The two-point angular correlation function for Soft (left) and Hard (right) sources.* $w(\theta) = 0$ *is the no correlation line. Our fits assume a power law model.*

the HELLAS2XMM survey. (Fig. 1, upper panels) (for further details see Carrera et al., 2006, in preparation).

3. THE ANGULAR CORRELATION FUNCTION

We have also calculated the two-point angular correlation function (ACF) of the AXIS sources seeking out for large -scale inhomogeneities. The ACF $w(\theta)$ is the joint probability of finding sources separated by an angular distance θ. Our estimator is the same used by Efstathiou et al., (1991) and by Basilakos et al., (2005). Hence, this function measures the excess of sources compared with that of a random distribution. In the absence of correlation $w(\theta) = 0$.

We have drawn a random sample of sources from our own source list taking into account the variations in sensitivity with the position in a given field. A source with a count rate above the sensitivity map in its position is kept in our random sample; otherwise, it is discarded and a new source is randomly drawn from the whole dataset. This way we have generated random catalogues with up to 1 million sources in each energy band.

Angular distances between all Data-Data (DD) and Data-Random (DR) pairs are calculated for each field. The number of DD pairs compared with the DR ones within a bin $\theta \pm d\theta$ (normalized by the total number of detected real and random sources) provides a measure of the ACF.

Our preliminary analysis show that evidences of clustering are found in Soft and XID bands with a significance of $\sim 3\sigma$ whereas in the Hard and UltraHard bands no significative detections are seen although some works (e.g. Basilakos et al., 2005) point in a different direction. (Fig. 1, lower panels).

Fitting the angular correlation function assuming a single power law model yields to slope values consistent with the canonical value of $\gamma = -0.8$ (Basilakos et al., 2005; Akylas et al., 2000; Maller et al., 2005) within the errors though a bit steeper (for further details see Carrera et al., 2006, in preparation).

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