ABSTRACT.
We summarize here some of the main results we have reached so far in the ASCA Hard Serendipitous Survey, a survey program conducted in the 2-10 keV energy band. In particular we will discuss the number-flux relationship, the 2-10 keV spectral properties of the sources, and the cross-correlation of the ASCA sources with ROSAT sources.

1. Introduction
The ASCA Hard Serendipitous Survey (HSS) is a systematic search for sources in the 2-10 keV band using data from the GIS2 instrument on board the ASCA Observatory. The specific aims of this project, initiated a few years ago at the Osservatorio Astronomico di Brera, are: a) to investigate the census of the X-ray sources shining in the hard X-ray sky down to a flux limit of $\sim 10^{-13}$ erg cm$^{-2}$ s$^{-1}$, b) to study their X-ray spectral properties, c) to test the Unification Model for AGN and d) to evaluate the contribution to the Cosmic X-ray Background (CXB) from the different classes of X-ray sources. Finally, this sample of 2-10 keV selected sources, along with other complete samples from ASCA and BeppoSAX survey programs (Ueda et al., 1999a,b; Giommi, Perri and Fiore, 2000) will be of fundamental importance in the next few years: a) to fix the bright tail of the much deeper Chandra and XMM-Newton number counts relationship and b) to provide sources bright enough for detailed X-ray follow up studies.

2. The ASCA HSS Sample
The data considered for the ASCA HSS were extracted from the public archive of 1629 ASCA fields (as of December 18, 1997). The fields selection criteria, the data preparation and analysis, the source detection and selection and the computation of the sky coverage are described in detail in the “pilot” paper (Cagnoni, Della Ceca and Maccacaro, 1998) and in Della Ceca et al. (1999a). In summary, we have considered 300 GIS2 images suitable for this project (e.g. at high galactic latitude, not centered on bright or extended targets, not centered on groups or associations of targets, etc..), using only the events in the 2-10 keV energy range and within 20 arcmin from the detector center. These images have been searched for sources with a signal-to-noise (S/N) ratio greater than
4.0 (a more restrictive criterion than that adopted in the “pilot” paper of Cagnoni et al. (1998) where a S/N ≥ 3.5 was used). A sample of 189 serendipitous sources with fluxes in the range ∼ 1 × 10^{-13} – ∼ 8 × 10^{-12} erg cm^{-2} s^{-1} has been defined. The fit, performed over the flux range (note that K is not a fit parameter but is obtained by rescaling the model to the actual given the different instruments and/or data analysis utilized from the various groups.

CXB emissivity recently obtained from Vecchi et al. (1999) using Beppo-erg cm-2 s^{-1}, we have spectroscopically identified. The optical breakdown is the following: 1 star, 5 cluster of galaxies, 5 BL Lacs, 40 Broad Line Type 1 AGN, and 7 Narrow Line Type 2 AGN. However, we stress that this sample of identified objects is probably not representative of the whole population. Full details on the ASCA HSS source sample will be reported in Della Ceca at al. (2001, in preparation).

3. The 2–10 keV LogN(>S) - LogS

In Figure 1 we summarize the results from different survey programs obtained using ASCA and BeppoSAX data in the flux range between ∼ 1 × 10^{-14} erg cm^{-2} s^{-1} and ∼ 1 × 10^{-11} erg cm^{-2} s^{-1}. The Chandra extension of the LogN(>S) - LogS down to ∼ 1 × 10^{-15} erg cm^{-2} s^{-1}, is discussed in Giacconi et al. (these proceedings).

It can be seen that the different results are in good agreement and this is reassuring given the different instruments and/or data analysis utilized from the various groups.

The ASCA HSS LogN(>S)-LogS can be described by a power law model N(>S) = K × S^{-α} with best fit values (±1σ) of α = 1.67 ± 0.09 and K = 2.85^{+0.19}_{-0.2} × 10^{-21} deg^{-2} (note that K is not a fit parameter but is obtained by rescaling the model to the actual number of objects in the sample). The fit, performed over the flux range ∼ 8 × 10^{-12} erg cm^{-2} s^{-1} – ∼ 7 × 10^{-14} erg cm^{-2} s^{-1} (the faintest detectable flux), is in very good agreement with our previous computations (e.g. Cagnoni et al., 1998, Della Ceca et al., 1999b) and with the BeppoSAX results (Giommi, Perri and Fiore, 2000). At the flux limit of the ASCA HSS survey (∼ 7 × 10^{-14} ergs cm^{-2} s^{-1}) the total emissivity of the resolved objects is ∼ 4.5 × 10^{-12} erg cm^{-2} s^{-1} deg^{-2}, i.e. about 20% of the 2-10 keV CXB emissivity recently obtained from Vecchi et al. (1999) using BeppoSAX data.

4. The 2-10 keV spectral properties of the sources

To investigate the spectral properties of the sources in the 2 – 10 keV range we defined the hardness ratio, HR2 = (H−M)/H+M, where M and H are the observed net counts in the 2–4 keV and 4–10 keV energy band respectively (see Della Ceca et al.,1999a for details). Figure 2a (HR2 vs. GIS2 count rate) shows a flattening of the mean spectrum of the sources with decreasing count rate as well as a large spread in the HR2 (or αE) distribution; this spread is the result of the convolution of the parent distribution with the measurement error distribution. To disentangle these two distributions we have applied the maximum likelihood method as explained in Maccacaro et al., 1988. The results on the “faint” and on the “bright” subsets are reported in figure 2b. We clearly detect a flattening of the intrinsic mean spectral properties of the sources which is significant at more than 99% confidence level. Our results on the mean energy index for the faint subset are in good agreement with those obtained from Ueda et al., 1999a in a
Fig. 1. The 2-10 keV LogN(>S)-LogS from different surveys (adapted from Giommi, Perri and Fiore, 2000). Filled dot: ASCA HSS (this work); crosses: ASCA LSS (Ueda et al., 1999a); open triangles: ASCA MSS (Ueda et al., 1999b); open squares: BeppoSAX 2-10 keV survey (Giommi, Perri and Fiore, 2000); open hexagon at $\sim 3.8 \times 10^{-14}$ erg cm$^{-2}$ s$^{-1}$: ASCA DSS (Ogasaka et al., 1998); solid line: BeppoSAX fluctuations analysis (Perri and Giommi, 2000).

similar flux range ($\alpha_E = 1.49 \pm 0.1$), while the results on the bright sample are in good agreement with the Ginga results (see Della Ceca et al., 1999a and reference therein).

5. The ASCA-ROSAT cross correlation

We have cross-correlated the ASCA HSS sources with existing ROSAT images (PSPC, HRI) and with the RASS catalogs. Only 11 of the 129 ASCA HSS sources, for which we have adequate ROSAT data, do not have a clear soft X-ray counterpart (all but 2 with $\alpha_E < 0.5$); therefore we do not find a compelling evidence for a large (> 9%) population of 2-10 keV sources undetectable below a few keV (see also Giommi, Perri and Fiore, 2000 for a similar results from the BeppoSAX 2-10 keV survey). In the popular and largely accepted absorbed AGN scenario, this result implies that soft spectral components must be present even in strongly absorbed objects as already stated from Giommi, Fiore and Perri, 1999 and Della Ceca et al., 1999a.
Fig. 2. Panel a: HR2 vs. GIS2 count rate for the complete ASCA HSS sample, compared with the HR2 expected from a non absorbed power-law model with $\alpha_E$ ranging from $-1.0$ to $2.0$. The flux scale on the top has been obtained assuming a conversion factor appropriate for $\alpha_E \sim 0.6$, the median energy spectral index of the sample. Note the presence of many sources which seem to be characterized by a very flat 2-10 keV spectrum with $\alpha_E \leq 0.4$ and of a number of sources with “inverted” spectra (i.e. $\alpha_E \leq 0.0$). Panel b: Confidence contours (68%, 90% and 99% confidence level) of the intrinsic dispersion of the spectral index distribution vs. the intrinsic mean energy index of the faint and bright subsets. The bright sample is defined by the 54 sources with a count rate $\geq 4.3 \times 10^{-3}$ cts s$^{-1}$, while the faint sample is defined by the remaining 128 sources. Seven sources with extreme spectral properties ($\alpha_E < -1$ or $\alpha_E > 2$) have been excluded from the analysis.

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